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Sales Forecast Uncertainty In The Screening Of New Industrial Products: A Descriptive Model With Predictive Implications

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SALES FORECAST UNCERTAINTY IN THE SCREENING OF NEW INDUSTRIAL PRODUCTS: A DESCRIPTIVE MODEL WITH PREDICTIVE IMPLICATIONS

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ABSTRACT

This thesis focuses on the errors in sales forecasts made by managers when screening new industrial product proposals for development. The aims of the research are to determine the levels of sales forecast error made by managers and to identify a set of factors that are associated with this error. A further aim is to test the predictive ability of a model based on the factors to assist managers in selecting new products for development by improving their evaluation of sales forecast uncertainty. The study is based on the use of scaled variables which can be evaluated using managerial judgment when a new product is first being considered for development by the firm, commonly referred to as the screening stage.

The first hypothesis of the study is that the level of sales forecast error made by managers when screening a new product is related to variables which describe the similarity of the marketing tasks required for the new product compared to those required for the existing products of the firm. The second hypothesis is that the level of sales forecast error is related to variables which describe the complexity of the marketing tasks required for the product in terms of three constructs; buyer risk, competitive advantage, and distribution ease. The first two hypotheses are descriptive in nature. The third hypothesis of the study is that the model developed in the study can significantly predict probabilities of different levels of sales forecast error in new product situations.

The empirical data for the study was based on 185 new product ventures undertaken by Canadian industrial goods firms. The sales forecast errors made by managers were found to be significantly related to 14 of the 23 variables describing marketing task similarity and complexity. Exploration of the structure of the predictor variables through factor analysis revealed a good degree of internal consistency for each of the constructs postulated in the descriptive model.

The predictive ability of the model was statistically significant but not strong in terms of improvement over a chance model. This suggests that further development of the model is required to derive a strong predictive tool. However, the descriptive findings of the study have identified a set of useful constructs representing characteristics of new product situations that are related to the sales forecast errors made by managers.

The major implications of the findings of the research are reported to formulators of public policy, business practitioners, and marketing theorists.

ACKNOWLEDGEMENTS

Although this thesis bears the name of only one person, it represents in a very real sense the combined interest, involvement and frequently the sacrifices of other people. It is to these people these thoughts are addressed.

Far more than simple thanks is due my thesis advisor Blair Little. In addition to arousing my interest in the problems of new product development and providing data from his own study for this thesis, Professor Little gave much of his time and energy in assisting me in every phase of this research. But more than this, he has been a friend in the most honest and critical sense. He has been at once demanding and supportive, a rare combination. Whatever strengths this thesis has are due largely to his guidance.

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The three research assistants employed by Professor Little, Mr. Louis Normand, Mr. Jerry de Planke, and Mr. Don Latta are thanked for the many hours they spent gathering the data for the research. I also thank Professor Robert Cooper, a fellow doctoral candidate for his assistance during the data collection phase, for his endless flow of useful ideas, and particularly for his warm and tolerant friendship.

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CHAPTER I

SALES FORECAST UNCERTAINTY IN NEW PRODUCT SCREENING

1.1. OUTLINE OF THE PROBLEM

1.1.1 Introduction

The successful development of new products through innovation represents an important element in the growth and success of industrial product firms. The initial selection of new product ideas for subsequent development represents a critical step in this development process. In this initial selection or screening two important criteria that should be considered by managers are the potential profitability of the product and the likelihood of this profitability actually resulting from development and marketing of the product.

This research focuses on the uncertainty of sales forecasts for new products, a key component of a profitability evaluation. The aim of the study is to identify some characteristics of industrial new product situations that are related to sales forecast errors made by managers when screening new products, and that are therefore related to uncertainty in their sales forecasts. A further aim is to contribute to the improvement of the new product development process by testing the ability of the model developed to assist managers in evaluating the uncertainty of their sales forecasts when they screen new products for possible development.

1.1.2 The Problem

Various sources have noted the reliance of individual firms and

industries on new products.[1] The importance of innovation to Canadian firms has recently received special emphasis, and technological innovation is now considered to be a vital element in the growth and stability of the Canadian economy. A recent Report of the Science Council of Canada noted that;

> the application of science and technology will make significant contributions to the solution of economic and social problems in Canada and in so doing will contribute to the realization of the goals of the nation. In order to have this happen, changes are necessary, in particular, more emphasis in future must be placed on development and innovation – on using science and technology to produce new or improved goods or services – and more research and development must be done close to the point where innovation will be initiated.[2]

A major deterrent to the development of new products is the high rate of failure experienced by many firms. Many sources have reported these failures.[3] One such study by Booz, Allen, and Hamilton indicated that seven out of eight hours spent by scientists and engineers on the development of new products are spent on products that fail at some stage in the process.[4] Failure of a new product in the market is frequently accompanied by errors in forecasts of revenue,

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[1]See for example, "Organization for New Product Development," *The National Industrial Conference Board*, 1966 Symposium Proceedings; W. N. Leonard, "Research and Development in Industrial Growth," *Journal of Political Economy*, March-April 1971, p. 232.

[2]"Towards a National Science Policy," *Science Council of Canada*, Queen's Printer, October, 1968, p. 1.

[3]See for example; "Planning Products for Profit," *New England Council*, Boston, Mass., 1953; P. Stillson, E. L. Arnoff, "Product Search and Evaluation," *Journal of Marketing*, July, 1957, p. 33; and G. Fellow, "On Introducing New Products," *Industrial Canada*, December 1970, p. 37.

[4]*Management of New Products*, Booz, Allen, and Hamilton Inc., New York, 1960.

costs, and investments, and therefore error in the estimate of profitability for the product.

The high failure rate and cost of failure for new products make it crucial for managers to evaluate the potential success of a new product idea as soon as possible in the development process, at the time when product proposals are first being considered for development. This process of initial new product selection is commonly referred to as screening, and can be defined as a rapid, low-cost economic evaluation of a new product proposal to evaluate its attractiveness to the firm before any major resources are committed to the product.[5]

An important step in screening a new product proposal is forecasting the sales for the product. Forecasting sales with a high degree of accuracy represents a serious problem for managers when screening new products. In a study of the practice of Canadian managers in evaluating new products, Shapiro and Aronchick found that forecasting sales accurately presented a major difficulty for Canadian managers and was strongly associated to the risk managers perceived in developing new products.[6]

How can managers improve their recognition of new product situations at the screening stage where the uncertainty of their sales forecasts is high? How can they determine which characteristics of a new product situation are most likely to contribute to errors in their sales forecasts? These are the primary problems addressed by this thesis.

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[5]E. A. Pessemier, *New Product Decisions, An Analytic Approach*, McGraw-Hill, 1966, p. 11.

[6]S. J. Shapiro, D. Aronchick, *The New Product Evaluation Process: Theory and Canadian Practice*, Working Paper, McGill University, 1972, p. 31.

1.2 CURRENT METHODS OF EVALUATING SALES FORECAST UNCERTAINTY IN SCREENING

This section outlines some current methods available for use by managers in evaluating the uncertainty of their sales forecasts in order to place this study in perspective.

1.2.1 An Overview

Current methods of evaluating sales forecast uncertainty in screening are found in the context of new product screening models. Models which address the overall screening decision process are found primarily in three broad areas of study, studies in marketing related to new product development, studies in research and development project management, and studies in operations research. All three areas of study have been utilized in the formulation of this research.

1.2.2 Classification of Current Methods

Screening models can be classified into two types on the basis of how they evaluate the uncertainty of forecasts of future outcomes such as sales forecasts: unstructured evaluation models and structured evaluation models.

1. Unstructured Evaluation Models

In models of this type, managers directly evaluate the uncertainty of their forecasts from their unstructured knowledge of a new product situation. The output of this uncertainty evaluation can be in different forms.

a) Uncertainty Expressed as a Probability Distribution

In this general type of model, the manager estimates an expected or most likely value for sales, then generates a probability distribution for actual levels of sales above and below the expected value. The variance of this distribution can

then be used as a measure of the uncertainty attached to the estimate.

Models of this type include those of Gottlieb and Roshwalb,[7] Freeman,[8] Freeman and Gear,[9] and Atkinson and Bobis.[10] In the approach of Gottlieb and Roshwalb, the probabilities of different sales levels are combined with the manager's utility function to generate a value for the expected utility of a particular project to the firm. Atkinson and Bobis propose the use of the probability distribution of sales in a Monte Carlo simulation to arrive at an expected value for sales.

b) Uncertainty Expressed as Probability of Success

In this general type of model, the manager subjectively estimates an overall probability of success for a new product venture which reflects his combined uncertainty in all the forecast variables, including sales. Models of this type include those of Hess and Cochran et al. The approach of Hess is based on dynamic programming, and uses a probability of success estimate in each period over the time of development of a particular new product.[11] Cochran et al propose the use of the probability of success estimate in a sensitivity analysis based on the value of this

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[7] M.J. Gottlieb, I. Roshwalb, "The Present Value Concept in Evaluating New Products," *New Ideas for Successful Marketing*, Proceedings of the American Marketing Association, 1966, World Congress, Chicago, 1966, pp. 387-400.

[8] R.J. Freeman, "A Stochastic Model for Determining the Size and Allocation of the Research Budget," *I.R.E. Transactions on Engineering Management*, March, 1960, p. 2.

[9] P. Freeman, A.E. Gear, "A Probabilistic Objective Function for R and D Portfolio Selection," *Operational Research Quarterly*, Vol. 22, No. 3, p. 253.

[10] A.C. Atkinson, A.H. Bobis, "A Mathematical Basis for the Selection of Research Projects," *I.E.E.E. Transactions on Engineering Management*, Vol. EM-16, No. 1, February, 1969, p. 2.

[11] S.W. Hess, "A Dynamic Programming Approach to R and D Budgeting and Project Selection, *I.R.E. Transactions on Engineering Management*, EM-9, 1962, p. 170.

probability required to reduce the profitability below an acceptable value.[12]

Each of the unstructured evaluation type of screening model results in some type of direct quantitative estimate of forecast uncertainty without any formal description or structuring of the particular new product situation. The manager arrives at the evaluation of forecast uncertainty using his implicit consideration of whatever factors in the situation he considers relevant.

2. Structured Evaluation Models

Models of this type present the manager with a set of qualitative variables which add structure to the evaluation of different attributes of a new product situation. The managers subjective evaluation of these variables provide a basis for his evaluation of forecast uncertainty. This evaluation can be in different forms.

a) Uncertainty expressed as a Probability Distribution

In these models, the manager generates a probability distribution of forecasts for the new product situation indirectly from his consideration of a set of structured qualitative factors.

Models of this type include those of Pessemier and O'Meara.[13, 14]

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[12]M. A. Cochran, E.B. Pyle, L.C. Greene, H.A. Clymer, A.D. Bender, "Investment Model for R and D Project Evaluation and Selection," *I.E.E.E. Transactions on Engineering Management*, Vol. EM-18, No. 3, August, 1971, p. 89.

[13]E.A. Pessemier, *New Product Decisions, An Analytical Approach*, McGraw-Hill, 1966, pp. 39-118.

[14]J.T. O'Meara, "Selecting Profitable Products," *Harvard Business Review*, Vol. 39, No. 1 (January-February), 1961, p. 83.

In the approach of Pessemier, two sets of qualitative situational variables are used, one set reflecting different aspects of the market environment for the product that may have some bearing on the potential market success of the product, the other set reflecting the ability of the company on several dimensions to exploit the market potential of the product. The manager uses these variables to assist him to generate a simple probability distribution for sales.

The approach of O'Meara is based on the calculation of an index from a set of qualitative factors which is then used by the manager in evaluating the probability of success for the new product venture. The index is calculated using a weighting scheme to reflect the relative importance of the different factors.

b) Uncertainty Expressed as a Probability of Success Index

In these models, the model itself provides a basis for calculating an index or set of indices from the qualitative factors which is then directly related to or taken as some measure of the probability of success for the new product venture. Models of this type include those of Dean and Nishry,[15] Richman,[16] Harris,[17] Wilson,[18] and Hart.[19]

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[15] B.V. Dean, M.J. Nishry, "Scoring and Profitability Models for Evaluating and Selecting Engineering Projects," *Operations Research*, 1965, No. 13, p. 550.

[16] B. Richman, "A Rating Scale for Product Innovation," *Business Horizons*, Summer, 1962, p. 37.

[17] J.S. Harris, "The New Product Profile Chart, Selecting and Appraising New Projects," *Chemical and Engineering News*, Vol. 39, No. 16, April 17, 1901, p. 110.

[18] A. Wilson, "Selecting New Products for Development," *Scientific Business* (U.K.), November, 1963, p. 256.

[19] A. Hart, "A Chart for Evaluating Product Research and Development Projects," *Operational Research Quarterly*, Q. 17, 1966, p. 345.

The approach of Dean and Nishry is based on the construction of a scoring model using a set of qualitative factors to determine the most important factors which influence the profitability of a new product venture. One subset of the qualitative factors are then related to the forecast of sales for the new product. The models of Richman and Wilson are based on sets of qualitative factors that are weighted and summed to yield a quantitative score for a new product proposal that can be compared to the scores for other proposals. The models of Harris and Hart express the profit-related outcomes such as sales as scales and combine these values with those of the qualitative situational factors to arrive at an overall score for a proposal, to be compared to other proposals.

Each of the structured evaluation type of screening model uses a set of qualitative situational variables to indirectly estimate or evaluate sales forecast uncertainty. The manager arrives at the estimate of forecast uncertainty using some explicit consideration of a structured set of qualitative characteristics of the new product situation.

This research is based primarily on the structured evaluation type of screening model, which attempts to relate non-quantifiable characteristics of the new product situation to sales forecast uncertainty.

1.2.3 Deficiencies in Current Methods

The survey of current structured evaluation models for estimating forecast uncertainty in screening revealed several deficiencies.

1. Lack of a Direct Evaluation of Forecast Uncertainty

Most current screening models do not evaluate forecast uncertainty in a form that is consistent with the screening decision faced by managers. In an extensive review of screening models Baker and Pound concluded that formal

screening models have not been implemented because they have not been designed specifically to fit the intrinsic structure of the project selection decision.[20] One important aspect of that problem was noted as the failure of most current models to recognize and take account of any potential errors in the estimates which constitute their inputs. A similar conclusion was drawn by Meadows in commenting on the use of formal models for screening.[21]

2. Lack of a Theoretical Basis for Variables

Existing models have not derived the qualitative variables used from a theoretical framework which shows the relationship of each variable to forecast uncertainty. The variables therefore tend to be very specific to particular managers in a particular firm or situation. This makes it difficult for managers both to compare projects and to learn from new product situations as they encounter them.

3. Lack of Empirical Testing

Existing models have not been based on an empirically tested set of variables or set of variable weights with which to consider the relative effect of different situational characteristics on forecast uncertainty.

4. Lack of a Linkage Between Subjective Variables and Forecast Uncertainty

Existing models have not attempted to directly link important qualitative situational variables to a measure of sales forecast uncertainty. This deficiency is generalized across many management decision models that include some

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[20] N.R. Baker, W.H. Pound, "R and D Project Selection: Where We Stand," *I.E.E.E. Transactions on Engineering Management*, December, 1964, p. 124.

[21] D.L. Meadows, "Estimate Accuracy and Project Selection Models in Industrial Research," *Industrial Management Review*, Spring, 1968, p. 105.

consideration of qualitative factors in the new product situation.

In discussing qualitative inputs to management decision models, Simon and Freimer noted that decision models are meant to only produce aids to strategy formulation, and are not meant to give definitive solutions or answers that say one solution is the only reasonable course to follow. A major reason for this is that there are frequently non-quantifiable elements in the environment which must be taken into account by managers to examine and estimate the effect of each subjective attribute upon the quantitative management conclusions reached.[22] The managers estimate of sales for the new product is an example of a quantitative conclusion reached from both quantitative and qualitative considerations. The importance of linking qualitative decision inputs to the quantitative decision was also stressed by Shepard; who noted that a major weakness of formal models is the absence of any explicit representation of subjective decision inputs. Shepard also noted experimental evidence that decision maker's ability to arrive at an overall evaluation of a decision alternative by weighing or trading-off separate qualitative attributes is unimpressive. He proposed that a closer approach to choice decision optimality might be achieved by analyzing such decision problems in two parts; evaluation of the separate qualitative and quantitative decision inputs by managers, then use of a computer based on an underlying model to combine the separate judgments to arrive at an overall decision.[23] A similar suggestion was made by Shocker, Gensch, and Simon is discussing potential improvements in new product screening models. They noted that many of the relevant measurement inputs to screening models are ordinal in

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[22] L.S. Simon, M. Freimer, "The Evaluation of Potential New Product Alternatives," *Management Science*, XII, February, 1967, pp. B-279 to B-292.

[23] R.N. Shepard, "On Subjectively Optimum Selections among Multi-attribute Alternatives," in *Decision-Making*, edited by W. Edwards, A. Tversky, Penguin Books, 1967, p. 257.

nature and that the analytical inclusion of these qualitative factors would represent a major improvement in screening models.[24]

The analytic linking of subjective factors with quantitative decision estimates is especially relevant for marketing decision models involving sales forecasts. Many of the related factors are qualitative and highly interactive with other factors. This multivariate nature of marketing decisions was noted by Montgomery and Urban as a major contributor to the importance of dealing with qualitative inputs analytically.[25]

1.3 THE BASIS FOR THE RESEARCH APPROACH

This section outlines the basis for the approach taken to the research problem. The research approach is based on contributions from four broad areas of theory in the formulation of a descriptive model.

Decision theory provides a basis for viewing the new product development process in terms of the management tasks and related task decisions faced by managers in developing and marketing a new product. This area of theory also identified two constructs which describe the management tasks, task similarity and task complexity.

Marketing theory provides a basis for outlining a set of marketing tasks faced by managers in the development and marketing of a new product. This area of theory also provides a basis to formulate a set of constructs which represent sources of task complexity in the market environment for a new product. Decision

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[24] A.D. Shocker, D. Gensch, L.S. Simon, p. 165.

[25] D.B. Montgomery, G.L. Urban, *Management Science in Marketing*, Prentice-Hall, Englewood Cliffs, New Jersey, 1969.

theory and marketing theory are utilized in this study to provide a theoretical basis for selection of variables.

The set of structured evaluation screening models provide a basis for the measurement of qualitative management judgments using scaled measures.

Multivariate model theory provides discriminant analysis as an appropriate analytic form for the descriptive model, directly linking qualitative management judgment variables to a quantitative measure of sales forecast uncertainty. The relationship of the four theoretical areas is shown schematically in Figure 1.1.

1.4 OBJECTIVES OF THE STUDY

In this section, the objectives of the research are restated in a more detailed manner. The ultimate objective of the study is to contribute to the improvement of the new product development process in industrial goods firms by studying sales forecast uncertainty and error in the screening decision process. There are several areas for improvement in the methods for evaluating sales forecast uncertainty at the screening stage. The specific objectives of this study are therefore;

1. to determine the levels of sales forecast error made by managers when screening industrial new products for development,
2. to identify some characteristics of new product situations that are related to the level of sales forecast error,
3. to develop a descriptive model which relates the level of sales forecast error to variables which describe the new product situations,
4. to attempt to derive predictive implications by testing the power of the descriptive model to predict sales forecast error in new product situations.

The first three of these objectives are descriptive in nature, the

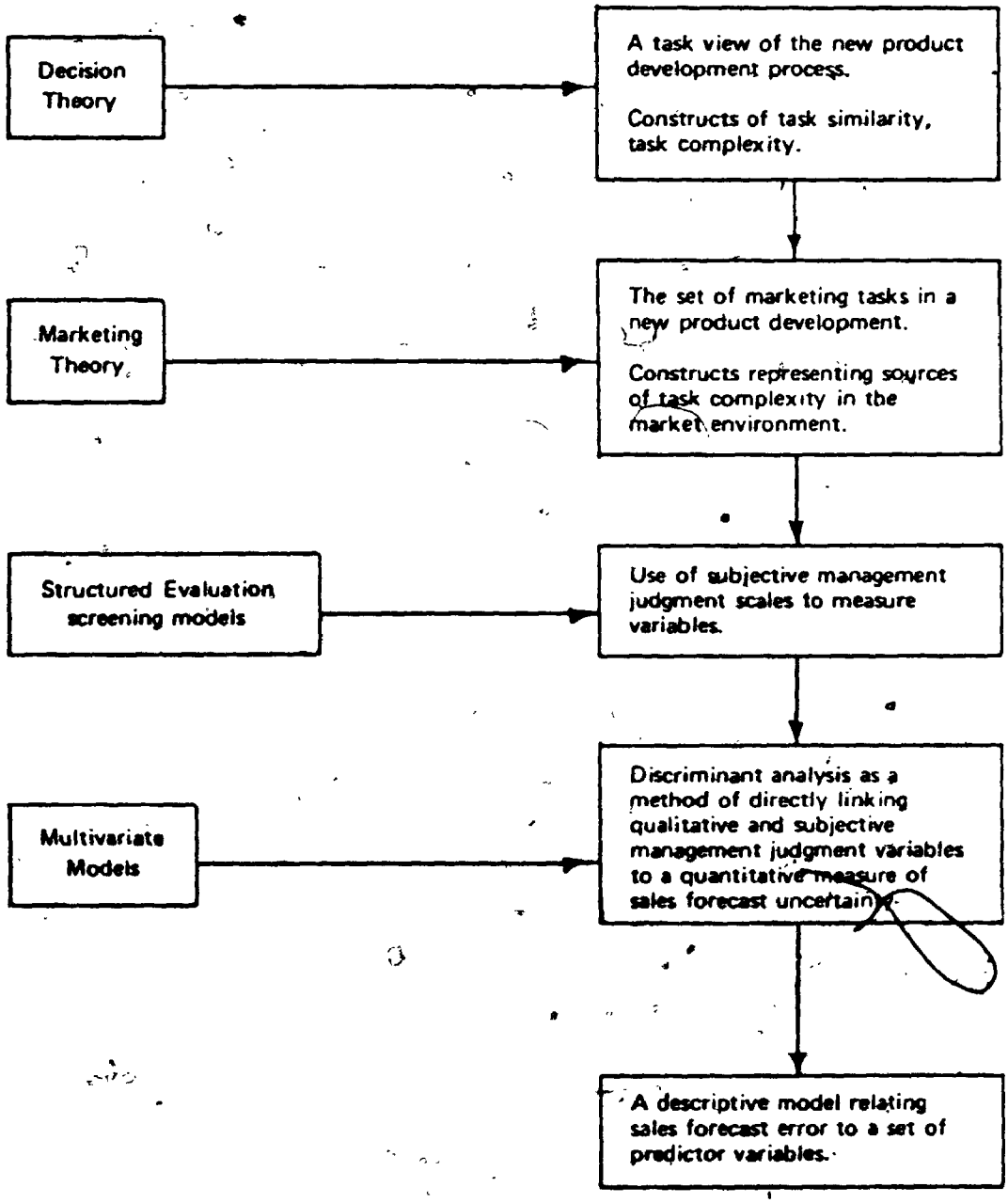

Figure 1.1
The research approach

fourth is normative and predictive.

1.5 THE SCOPE OF THE RESEARCH

This section describes the scope of the research in terms of the types of firms and new product situations studied. The study is based on industrial new products, excluding consumer products. The products studied are mass-market type products, excluding job-shop type products.

The term industrial products refers to those in which the manufacturer is concerned with buyers who use them in connection with the goods and services they in turn produce. It is contrasted with consumer products where goods and services are sold (either directly or through middlemen) to buyers who will use them for the personal satisfaction of themselves and their families.[26]

New products, for the purpose of this study are products new to the selling company, even though they may be established in the market by another firm. Johnson and Jones provide a classification system which identified two dimensions of product newness, technical newness and market newness. This scheme has been used as the criterion of the product newness for the selection of the sample of new product situations in this study.[27]

A mass-market new product situation is one in which a new product is initially developed for more than a single customer, and precludes the custom made job-shop type of product.

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[26] L. Fisher, p. 11 (based on a definition by E.R. Corey in *Industrial Marketing*, Prentice-Hall, 1962).

[27] S.C. Johnson, C. Jones, "How to Organize for New Products," *Harvard Business Review* (May, June, 1957), p. 52.

1.6 THE THESIS PLAN

This section outlines the overall plan of the thesis. The first chapter has outlined a managerial problem in the screening of industrial new products, evaluation of the uncertainty of sales forecasts. An examination of current methods for evaluating sales forecast uncertainty in screening models revealed deficiencies and opportunities for improvement.

The basis for the research approach was outlined in terms of contributions from four broad areas of theory. The specific research objectives and the questions addressed in the research were presented. The scope of the research was outlined.

In Chapter II, a conceptual framework is outlined to form the theoretical basis for development of the descriptive model for the research. The screening stage in a new product development is placed in the context of the process of developing and marketing new products. The new product development process is then viewed in terms of the management tasks to be performed and the decisions related to these tasks.

In Chapter III, the hypothesized descriptive model is developed. The model proposes that the level of sales forecast error made by managers when screening a new product is related to variables that describe the similarity and complexity of the set of marketing tasks faced by managers in the situation.

In Chapter IV, the hypotheses of the research are outlined. Chapter V outlines the methodology of the research. The methods of data collection and data analysis are reviewed. Chapter VI presents the major empirical findings of the research, while Chapter VII is a summary and discussion of the implications of the research findings.

CHAPTER II

BACKGROUND: THE SCREENING DECISION PROCESS

2.1 INTRODUCTION

A theoretical framework is developed in this chapter for viewing screening in the context of the overall process of the firm in developing and marketing new products. Development of this framework is the first step toward development of the hypothesized descriptive model for the research. The chapter begins with an overview of the screening stage in the firms development process for a new product. Next, the process is viewed in terms of the management tasks to be performed by managers of the firm and the decisions related to these tasks.

Uncertainty at the screening stage is then expressed in terms of the uncertainty of task decisions and the uncertainty of the future outcomes related to the decisions. It is suggested that there is a positive relationship between the two uncertainties. This relationship is central to the subsequent development of the descriptive model for the research.

Two constructs are derived and defined to form the basis for the descriptive model, task similarity and task complexity. For a given management task in a new product development, it is suggested that greater similarity and lower complexity of the task is related to lower uncertainty of the related outcomes.

2.2 THE SCREENING DECISION PROCESS: A THEORETICAL FRAMEWORK

2.2.1 The Screening Stage in a New Product Development

The development of new products by a firm is a complex organizational and technological process that takes place over time. The process in a particular firm is unique in many respects to the managers of that firm developing a particular technology and product at a particular time. Nonetheless, some common elements have emerged that are useful in characterizing and studying the new product process of all firms.

The process can be characterized as a series of stages taking place over time. Each stage in the process represents a decision process made up of a set of managerial activities terminated by a decision. These stages characterize the implicit behavior of the firm in developing a new product, although the order, exact nature, and duration of the stages may vary considerably in practice between firms and between different new product situations within a particular firm.

The stages in a new product development process can be characterized as follows,[1]

Search: Studies designed to locate potentially profitable additions to a firms product lines or capabilities.

Screening: Rapid low-cost studies which eliminate weak proposals and informally weigh the relative desirability of promising proposals.

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[1]These stages are derived from E.A. Pessemier, pp. 10-11.

Formal Economic Analysis: Careful detailed studies to clarify, improve, and appraise the proposals that survive preliminary analysis.

Development: Transformation of the proposal into a tangible product or process.

Product Testing: Conduct of use and market tests to measure the reactions of resellers and final buyers to the product.

Commercialization: Involvement in full-scale production and marketing operations to establish the product in its desired place in the firms product line.

Other sources have defined similar stages in the new product development process. Montgomery and Urban viewed development as a four-stage process: generation of new product ideas, screening these ideas to identify the most promising ones, detailed analysis of the resulting product proposals, and implementation of acceptable new products.[2] Simon and Freimer also categorized a similar set of stages in the product development process: a product idea accumulation phase; a screening phase, in which the many ideas uncovered in the first stage are reduced to a few worthy of further exploration; a product-structuring phase, in which the physical characteristics of the product that are most amenable to the firms production and marketing systems or contemplated systems are worked out; a market-testing phase; and the addition of the product to the firm's regular product line, or

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[2]D.B. Montgomery, G.L. Urban, ***Management Science in Marketing***, 1969, Prentice-Hall, Englewood Cliffs, New Jersey, p. 294.

commercialization.[3] Weichman viewed the development of new products as a process comprising four stages: generation of new product ideas, screening of those ideas to identify the most promising ones and to appraise their compatibility with company goals and capabilities, economic analysis of the remaining proposals, and implementation of acceptable new product proposals.[4]

In all of these schemes for outlining the stages in the process of new product development by the firm, screening has been commonly characterized as a decision-making process beginning with a proposal for a new product and ending with a decision to either expend funds on some phase of development of the product, drop the idea or hold it in abeyance. This study is concerned with forecasts of sales made by managers at this stage of a new product development.

2.2.2 A Task View of the New Product Development Process

The new product development process of the firm can also be viewed in terms of the tasks managers face between the screening stage and commercialization stage for a new product. These management tasks represent activities of the firm in which management decisions must be made over the entire time span of development of a product. This task view of the process of new product development is similar to that of Simon and Newell, who characterized managers as information-processing systems confronted by tasks in a task environment.[5] The

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[3]L.S. Simon, M. Freimer, *Analytical Marketing*, Harcourt, Brace, and World, 1970, p. 59.

[4]U. Weichman, *Note on Models for New Product Decisions*, Harvard Business School, note 9-571-079, M541, 1971.

[5]H.A. Simon, A. Newell in a comprehensive review; "Human Problem-Solving – The State of the Theory in 1970," *Journal of the American Psychological Association*, Vol. 26, 1971.

nature of the major tasks confronting managers in a new product situation can be delineated in terms of functional areas; marketing tasks, production tasks, and research and development tasks. This set of tasks are parallel to those delineated by Lorsch as the basic subsystems in the organization involved in product innovation.[6]

This view of the new product development process is shown in simplified form in Figure 2.1.

2.3 UNCERTAINTY IN THE SCREENING DECISION PROCESS

The screening process in the firm has been characterized as a decision-making process. It involves consideration by managers of a number of decision criteria and terminates in a decision. Since the decision is based partly on forecasts of future events and outcomes it is a decision process under conditions of uncertainty.

Two related components of uncertainty faced by managers when screening a new product can be identified; uncertainty of task decisions, and uncertainty of the future outcomes related to these decisions.

2.3.1 Uncertainty of Task Decisions

Between the screening stage and commercialization stage, a large number of decisions must be made by managers related to different management tasks. At the screening stage, managers face uncertainty related to the nature of the task decisions to be made during the product development. Task uncertainty was identified by both Lorsch and Sandkull as an important factor in the organizational

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[6]J.W. Lorsch, *Product Innovation and Organization*, The MacMillan Company, New York, 1965, p. 7.

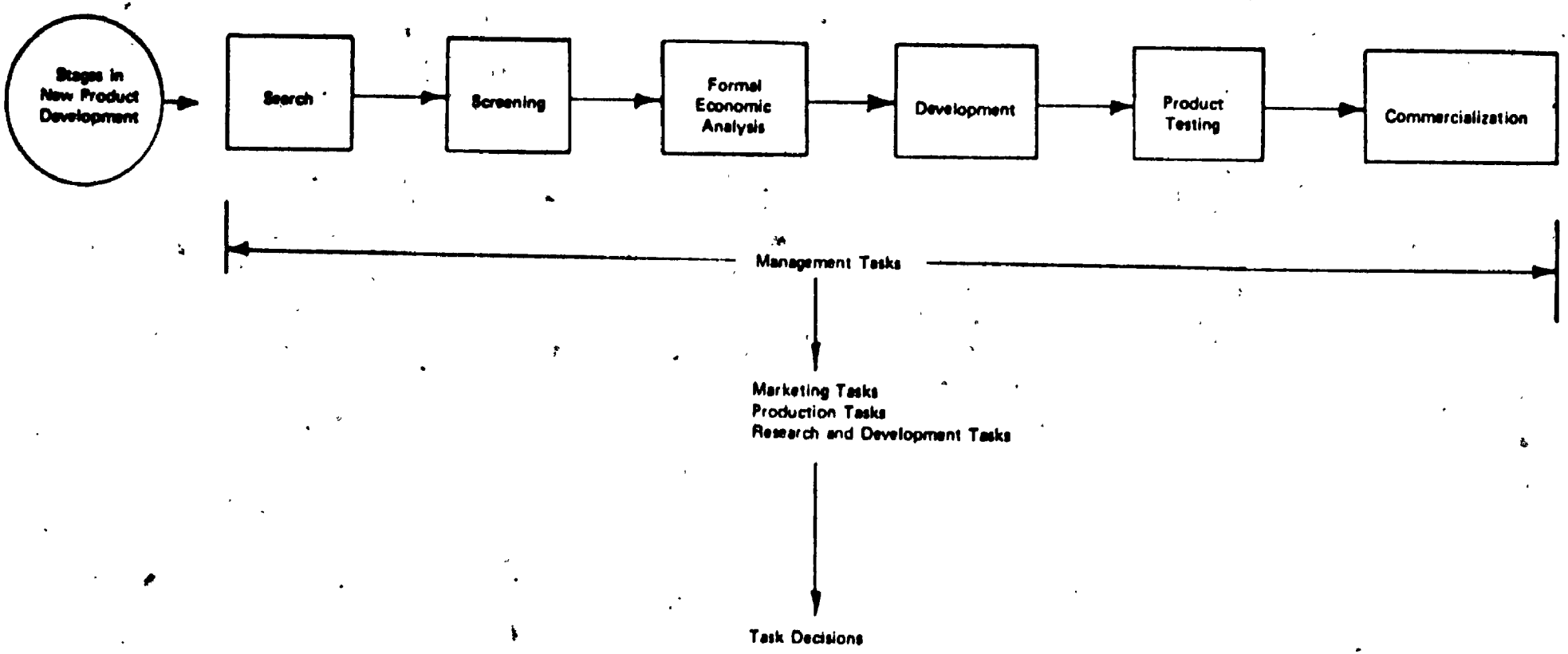

Figure 2.1
A Simplified Task View of the New Product Development Process.

behavior of firms developing innovative new products.[7,8] Lorsch also identified the tasks of the sales organizational unit as being relatively uncertain compared to the other organizational units.[9].

2.3.2 Uncertainty of Outcomes

At the screening stage managers also have uncertainty about the future outcomes that will occur when the new product is marketed. These future outcomes can be considered as partly the outcomes of the task decisions that managers have made.

2.3.3 Relationship of Uncertainties of Task Decisions and Outcomes

The concepts of uncertainty of task decisions and uncertainty of outcomes are parallel to those identified by Emory and Niland in their discussion of prediction in decision-making. It was noted that the most difficult problem in the judgmental stage of decision-making is that of predicting the outcomes of possible courses of action. It calls for careful deliberation on, and projection of, one's expectations into the future. The type of intellectual effort required to project one's thoughts from the known into the unknown is frequently evaded and the prediction of consequences of courses of action is no exception to this rule.[10]

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[7]J.W. Lorsch, p. 28.

[8]B. Sandkull, *Innovative Behavior of Organizations: The Case of New Products*, SIAR, Student Literature, printed in Lund, Sweden, 1970, p. 88.

[9]Lorsch identified the organizational unit involved in marketing activities as the sales unit.

[10]W.Emory, P. Niland, *Making Management Decisions*, Houghton Mifflin Company, Boston, 1968, p. 96.

In discussing consumer decision processes, Cox identified a parallel concept of uncertainty.[11] The level of risk faced by a consumer in making a purchase decision was expressed as a function of the consequences or outcomes of the decision and the consumer's uncertainty of these consequences occurring as a result of his/her decision. The consumer's purchase decision is analogous to the managers task decisions, although much less complex in terms of the number of possible decisions and the number of decision variables. In addition, the manager must make a set of task decisions sequentially over a long period of time. The consumer's uncertainty of consequences as defined by Cox is analogous to the uncertainty of outcomes faced by a manager.

2.4 SOURCES OF TASK DECISION UNCERTAINTY

Two constructs have been identified in this research as sources of task decision uncertainty, task similarity and task complexity.

2.4.1 Task Similarity

The construct of task similarity describes the extent of similarity of the set of management tasks in a new product situation compared to the tasks for existing products of the firm. In a new product situation, greater task similarity can mean greater similarity of the marketing tasks, production tasks, or research and development tasks. Greater similarity of the management tasks will lead to more similar task decisions. Managers faced with a familiar set of task decisions will have more information available to utilize in forecasting future outcomes related to those

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[11] D.F. Cox, "Risk-Taking and Information Handling in Consumer Behavior," in *Risk-Taking and Information Handling in Consumer Behavior*, Edited by D.F. Cox, Division of Research, Graduate School of Business Administration, Harvard University, Boston, 1967, p. 603.

tasks at the screening stage. They will also tend to have greater experience with the task decisions to be made in the future. As a result, greater task similarity will be related to lower task decision uncertainty, and therefore to the probability of lower errors in forecasting future outcomes related to the tasks.

In their review of contemporary decision theory, Simon and Newell noted that in the face of a task environment, two sources of information managers can utilize are previous experience with the same task, with a nearly identical one, with analogous tasks, or with components of the whole task.[12]

Because of the lower uncertainty of more similar new product situations, Pessemier noted that many firms tend to seek new product opportunities that permit the use or extension of their special technical, marketing, or production skills.[13] By selecting new products with greater similarity or fit to the existing products of the firm, the firm can increase the probability of effective development and successful commercialization. The effect of similarity of a new product in increasing the probability of new product success by reducing uncertainty was also noted by Richman,[14] Simon and Freimer,[15] and Staudt and Taylor.[16]

The relationships between task similarity and error in forecasts of the related outcomes are shown in Figure 2.2.

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[12]H.A. Simon, A. Newell.

[13]E.A. Pessemier, p. 8.

[14]B.M. Richman.

[15]L.S. Simon, M. Freimer, *Analytical Marketing*, Harcourt Brace and World, 1970, p. 57.

[16]T.A. Staudt and D.A. Taylor, *A Managerial Introduction to Marketing*, Prentice-Hall, Englewood Cliffs, N.J., 1965, Ch. 9.

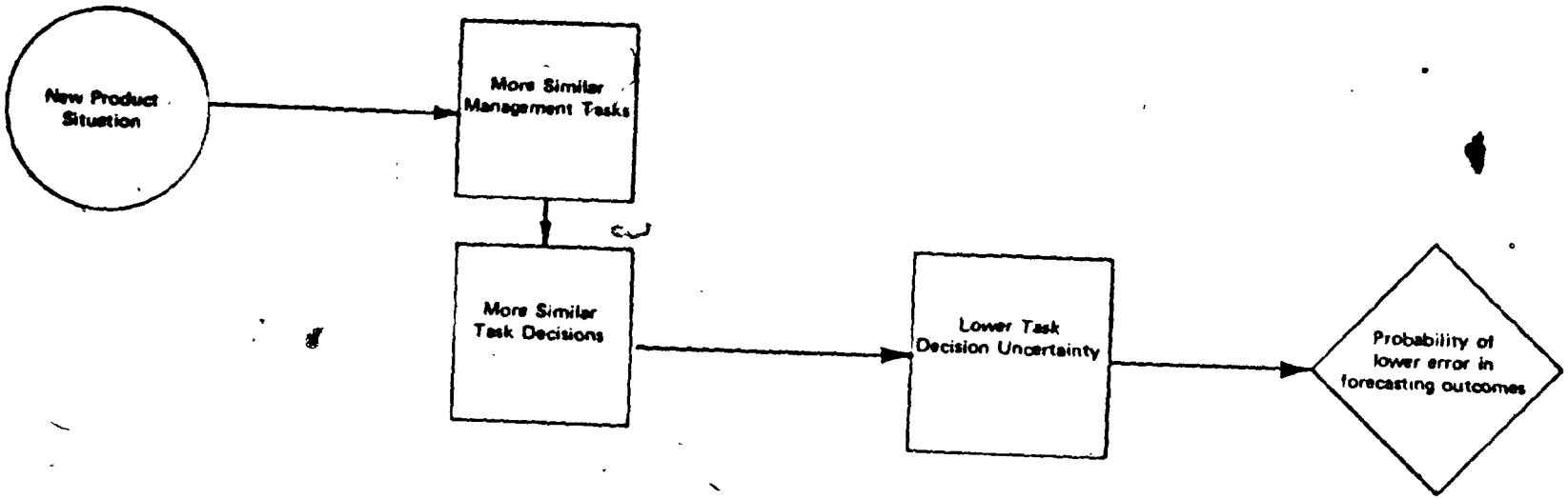

Figure 2.2
Relationship of Task Similarity to Forecast Error.

2.4.2 Task Complexity

The construct of task complexity describes the complexity of the decisions related to the set of management tasks in a new product situation. For a particular management task, complexity is greater when a greater number of decision variables enter the decision process and a greater number of decisions are involved. Given the inherent uncertainty of decisions involving future events and outcomes, a greater number of decisions and decision variables faced by managers will tend to increase task decision uncertainty and therefore lead to the probability of higher errors in forecasting future outcomes related to the particular task.

This concept of task complexity is parallel to that outlined by Emory and Niland in discussing complexity related to non-programmed decision situations. Decision complexity was defined in terms of a greater number of variables being considered in the decision and the presence of variables that are less predictable or measurable.[17]

Decisions are programmed to the extent that they are repetitive and routine, and to the extent that a definitive procedure has been worked out for handling them so that they do not have to be treated as new problems each time they occur. "Decisions are non-programmed to the extent that they are novel, unstructured, and consequential. There is no cut-and-dried method for handling the problem because it has not arisen before or because its precise nature or structure are elusive or complex.[18] Because of the relatively small number of new products

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[17] W. Emory, P. Niland, p. 96.

[18] H.A. Simon, *The New Science of Management Decisions*, Harper and Row, 1960, pp. 5, 6.

developed by most firms, and the relatively long development time, the great majority of new product developments represent non-programmed decision situations.

A similar concept of task complexity was related by Sandkull to the number of decisions to be made, in particular those between different organizational units performing different tasks in a new product development.[19] The author noted that a new product project characterized by a very complex task structure increases the difficulty faced by the firm.[20] Lorsch concluded that organizational units performing simple tasks tended to have higher structure than those performing more complex tasks.[21]

Task complexity has been related to decision-making in a number of experimental studies. Pitz viewed task complexity in terms of the number of decision variables involved in studying respondant's ability to predict the effectiveness of a complex mechanism on the basis of tests of a large number of individual components of the mechanism.[22] Strub also defined a complex decision task in terms of the number of decision variables related to the number of samples respondants required to make inferences or decisions on a universe of objects.[23] In an experimental study of how decision-makers combine information cues in drawing inferences, Summers et al viewed the complexity of the task in terms of the numbers of cues or variables

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[19] B. Sandkull, p. 88.

[20] *Ibid.*

[21] J. Lorsch, p. 11.

[22] G.E. Pitz, "The Influence of Prior Probabilities on Information-Seeking and Decision-Making," *Organizational Behavior and Human Performance*, 4, 1969, pp. 213-226.

[23] M.H. Strub, "Experience and Prior Probability in a Complex Decision Task," *Journal of Applied Psychology*, 1969, Vol. 53, No. 2, pp. 112-117.

presented to the respondants.[24] Some experimental evidence has shown that decision situations involving a greater number of decision variables or situational attributes produce a marked rise in errors in prediction of the associated outcomes.[25]

The relationships between task complexity and error in forecasts of outcomes is shown in Figure 2.3.

2.5 SUMMARY

This chapter has developed a conceptual framework which forms the basis for the descriptive model for the research. The process of the firm in developing new products has been viewed in terms of the tasks managers must perform and the decisions related to these tasks. From this, two components of management uncertainty in screening new products have been identified; uncertainty of task decisions, and uncertainty of the outcomes related to these decisions. These uncertainties have a positive relationship.

Two major constructs were suggested as sources of task decision uncertainty; task similarity and task complexity. These two constructs form the basis of the hypothesized descriptive model developed in the next chapter.

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[24] S.A. Summers, R.C. Summers, V.T. Karkau, "Judgements Based on Different Functional Relationships between Interacting Cues and a Criterion," *American Journal of Psychology*, Vol. 82, 1969, p. 211.

[25] E.J. Archer, L.E. Bourne, F.G. Brown, "Concept identification as a function of irrelevant information and instructions," *Journal of Experimental Psychology*, 49, pp. 153-164.

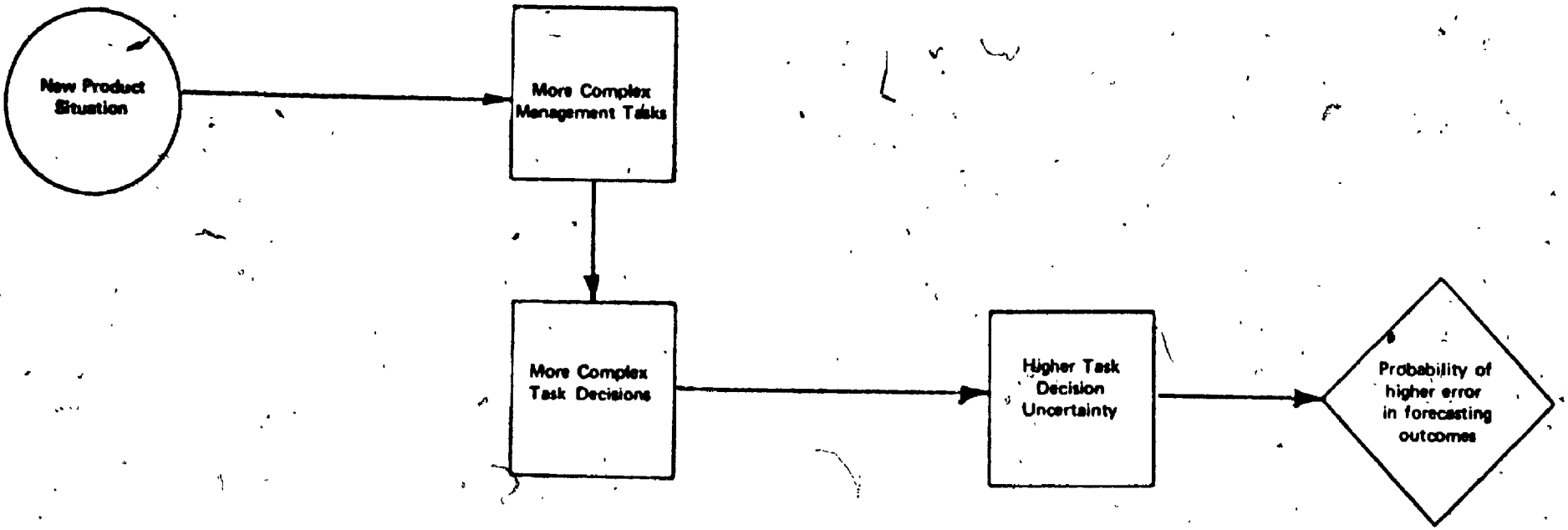

Figure 2.3
Relationship of Task Complexity to Forecast Error.

CHAPTER III

DEVELOPMENT OF THE DESCRIPTIVE MODEL

3.1 INTRODUCTION TO THE MODEL

The focus of this research concerns the sales forecast errors made by managers when screening new products for development. This chapter develops the hypothesized descriptive model of this research. The model hypothesizes that the level of sales forecast error made by managers when screening a new product is related to variables which characterize the marketing tasks faced by the firm.

The development of the model is based on the conceptual framework outlined in Chapter II. Using the task view of the new product development process, the model describes the set of marketing tasks facing managers of the firm. Using the concepts of uncertainty developed in the Second Chapter, sales forecast uncertainty is related to uncertainty of the marketing task decisions. The constructs of task similarity and task complexity are applied to the set of marketing tasks. It is hypothesized that when marketing task similarity increases and marketing task complexity decreases, the probability of error in sales forecasts is reduced.

A set of predictor variables is derived which describe the new product situation in terms of marketing task similarity and complexity. The first set of variables in the model are those describing the similarity of the marketing tasks. The construct of marketing task complexity is related to the three central elements in the market environment for a new product; potential buyers, potential competitors, and potential distributors using the constructs of buyer risk, competitive advantage, and

distribution ease. The second set of variables in the model describe these three constructs. The basic framework for the descriptive model is shown in Figure 3.1.

The analytic form of the model is an important part of the model formulation apart from data analysis. The output of a discriminant analytic model is consistent with a commonly-used method for expressing forecast uncertainty in terms of a probability distribution. The basis is outlined for two mathematical forms of the model, an additive model and a multiplicative model.

3.2 THE DEPENDENT VARIABLE: SALES FORECAST ERROR

The dependent variable in the descriptive model is the absolute level of sales forecast error made by managers in screening new products. This absolute error includes both positive errors (actual sales greater than forecast) and negative errors (actual sales lower than forecast). For this study, absolute sales forecast error was used as the dependent variable rather than signed error (positive vs. negative error) for the following reasons;

a) The desired output of the model used in prediction is a measure of sales forecast uncertainty in terms of a probability distribution reflecting the probabilities of different levels of error. The use of signed error for a given number of groups reduces the number of levels of error that can be discriminated between by the model. If the number of groups is increased, the discriminating ability of the model tends to be reduced.

b) There is no strong theoretical basis to suggest that certain variables in the model might be more likely to lead to negative errors than positive errors.

In the case where the model is framed as a predictive model, the

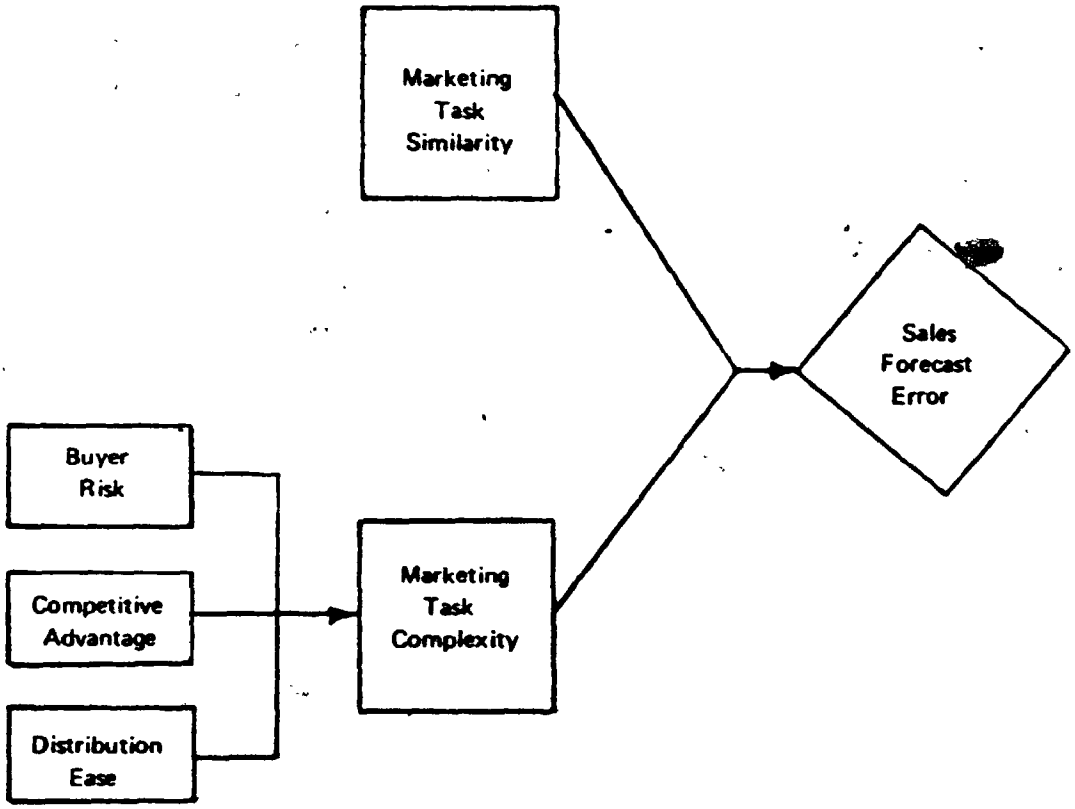

Figure 3.1
Simplified version of the Descriptive Model

predicted variable is a probabilistic measure of different levels of sales forecast error which is analogous to ranges on a probability distribution of sales forecasts.

3.3. MARKETING TASK DECISIONS AND SALES FORECAST UNCERTAINTY

This section describes the marketing tasks faced by managers in a new product situation. Uncertainty of the marketing task decisions is related to sales forecast uncertainty and error. The purpose of this section and the next are to provide the basis for definition of the predictor variables in the model.

3.3.1 Marketing Tasks in a New Product Development

A task view of the new product development process was described in the Second Chapter. The set of marketing tasks facing managers can be delineated in a new product situation. These tasks represent management activities in which managers must make strategic marketing decisions in taking the product from an idea to a commercial product. The following set of marketing tasks have been utilized in this research;

product performance task

pricing task

personal selling task

advertising/promotion task

distribution task

competitive strategy task.

These tasks are consistent with those outlined by several sources in the field of general marketing theory.[1]

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[1]See for example, L.S. Simon, M. Freimer, *Analytical Marketing*, Harcourt, Brace and World, 1970, p. 60, and D.B. Montgomery, G.L. Urban, *Management Science in Marketing*, Prentice Hall, 1919, p. 49.

3.3.2 Uncertainty of Marketing Task Decisions

The concept of task decision uncertainty can be applied to the set of marketing tasks in a new product situation. At the screening stage for a new product, managers have some uncertainty about the decisions they will make in the future related to each of the marketing tasks.

3.3.3 Relationship to Sales Forecast Uncertainty and Error

In Chapter II, it was suggested that task decision uncertainty is positively related to the uncertainty of forecasts of outcomes related to that task. Sales for a new product is an outcome of product development and marketing that is directly related to the effectiveness of the marketing tasks carried out by managers. Sales forecast uncertainty can therefore be related to marketing task decision uncertainty.

3.4 SOURCES OF MARKETING TASK DECISION UNCERTAINTY: THE MODEL CONSTRUCTS

This section takes the constructs of task similarity and task complexity and applies them to the set of marketing tasks faced by managers. The resulting constructs of marketing task similarity and marketing task complexity form the basis for selection of the predictor variables for the model.

3.4.1 Marketing Task Similarity

The construct of marketing task similarity describes the similarity of the set of marketing tasks in a new product situation compared to the marketing tasks for existing products of the firm. In a new product situation, greater marketing task similarity can mean greater similarity of the product performance task, pricing task, personal selling task, advertising/promotion task, distribution task, and competitive strategy task.

Managers facing a new product situation with greater marketing task similarity will face a more similar set of marketing task decisions. The probability of error in their forecasts of the outcome of sales will tend to be lower.

The hypothesized relationships between marketing task similarity and sales forecast error are shown in Figure 3.2.

3.4.2 Marketing Task Complexity

The construct of marketing task complexity describes the complexity of the marketing task decisions facing managers in a new product situation. In a new product situation, greater marketing task complexity can mean a greater number of decisions and decision variables related to the product performance task, pricing task, personal selling task, advertising/promotion task, distribution task, and competitive strategy task. Managers facing a new product situation with greater complexity of the marketing tasks will tend to have a greater probability of error in their sales forecasts.

3.4.3 Sources of Marketing Task Complexity

This study has identified three constructs which describe sources of marketing task complexity in the market environment faced by the firm in developing and marketing a new product. The three major groups or elements in the market environment which determine overall market response to a new product are potential buyers, competitors, and distributors. These elements are similar to those typically described in describing the market environment.[2] The constructs of buyer

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[2]See for example, W.R. Dill, "Environment as an Influence on Managerial Autonomy," *Administrative Science Quarterly*, Vol. 2, (March, 1958), 409-443.

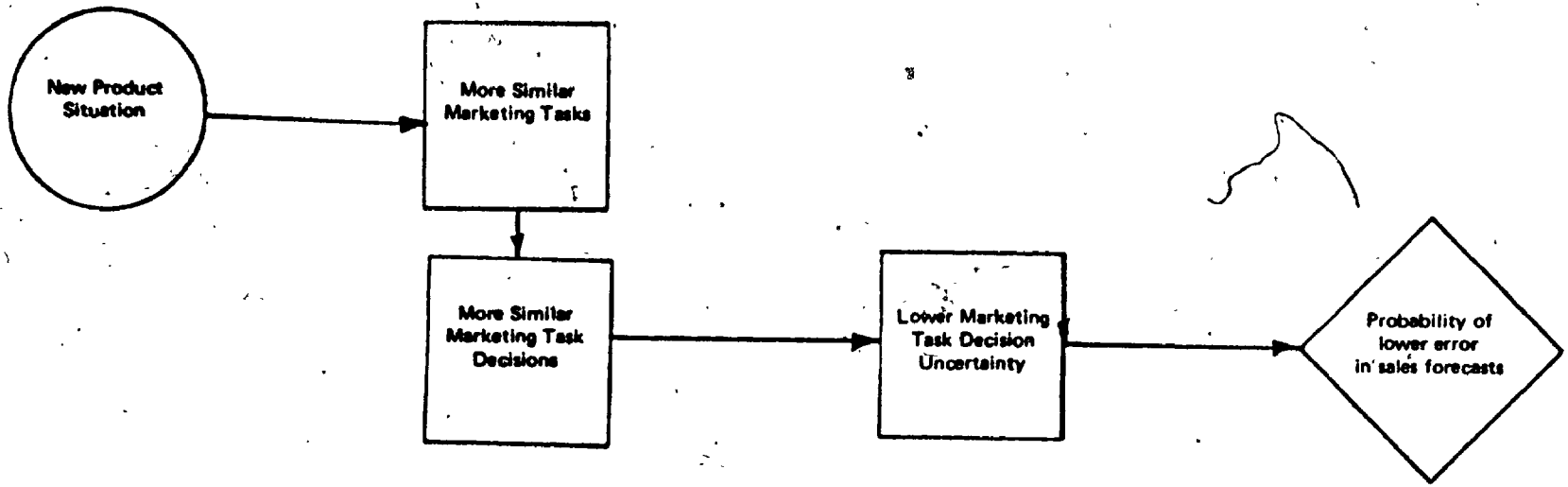

Figure 3.2
Hypothesized Relationship of Marketing Task Similarity to Sales Forecast Error

risk, competitive advantage, and distribution ease describe characteristics of each element in the market environment which introduce complexity into the marketing tasks faced by the firm developing a new product.

3.4.3.1 Buyer Risk

The construct of buyer risk describes risks faced by potential buyers in purchasing a new product. Greater risk to the buyer will tend to introduce complexity into his purchase process by increasing the number of decision criteria considered, the time taken to make the purchase decision, and the extent of organizational involvement. Increased complexity in the purchase process of the buyer will tend to increase the complexity of the marketing tasks faced by managers of the selling firm.

This view of buyer risk is analogous to that developed by Fisher in outlining the complexity of the buying decision process. The buying procedure of the firm, and therefore the marketing strategy of the seller to match it was related to two constructs, product complexity and commercial uncertainty.[3] Greater risk to the buyer was related to greater product complexity and greater commercial risk. Product complexity was defined as arising as a result of the impact of the technology of a new product on the existing knowledge of the customer and commercial uncertainty was defined as arising when the purchase decision involves business risk to the customer because of its potential implications for the buyer's future profits.[4] Fisher then defined each of the two constructs in terms of sets of variables. It was

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[3] L. Fisher, *Industrial Marketing: an analytical approach to planning and execution*, Business Books Limited, London, England, 1969, p. 20.

[4] *Ibid.*

postulated that as product complexity and commercial uncertainty increase, the complexity of the purchase decision also increases, with more decision-makers generally involved at a greater number of levels in the buying organization.[5] This effect of buyer risk in increasing the complexity of the purchase process was also noted by Robinson, Faris, and Wind in a study of industrial product purchases.[6]

3.4.3.2 Competitive Advantage

The construct of competitive advantage describes advantages held by the firm developing and marketing a new product compared to competitive firms in the generic product market. Greater competitive advantage for the firm will tend to reduce the complexity of the marketing tasks faced by managers by reducing the number of decisions and decision variables faced for the marketing tasks.

3.4.3.3 Distribution Ease

The construct of distribution ease describes the ease or absence of difficulty the firm may have in selecting and securing appropriate channels of distribution for the new product in the market. In marketing a new product which requires other members in a distribution channel availability and support of the required distributors can be critical. Ease of distribution depends upon the response to the new product by the potential distributors involved. Greater ease of distribution for the firm will tend to reduce the complexity of the marketing tasks faced by managers by reducing the number of decisions and decision variables faced for the marketing tasks.

The interdependence between members of distribution channels and

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[5] *Ibid.*

[6] P.J. Robinson, C.W. Faris, Y. Wind, *Industrial Buying and Creative Marketing*, Allyn and Bacon Inc., Boston, 1967, p. 115.

the importance of the power of different channel members to support or constrain the behavior of other members was outlined by Stern in focusing on the behavioral aspects of distribution channels viewed as social systems.[7] He noted three major implications of a system's view of distribution channels; that each member of a distribution channel is dependent upon the behavior of other channel members, that a behavior change at any point in the channel causes change throughout the channel, and that the whole channel must operate effectively if the desires of any one member are to be realized. He also noted that a firm must have some means of predicting the behavior of other channel members.[8] The relative power of different members of a distribution channel is also important. Power is pervasive in a distribution channel because each member is dependent to some extent on the others. As one channel member's dependence upon another increases, the greater becomes the power of the latter.[9]

The hypothesized relationships between buyer risk, competitive advantage, distribution ease and sales forecast error are shown in Figure 3.3.

3.5 DESCRIPTION OF THE PREDICTOR VARIABLES

This section describes the proposed predictor variables in the descriptive model. The variables define the constructs of marketing task similarity and marketing task complexity. The relationships between the predictor variables and the constructs suggest the effect that each variable will likely have on the sales forecast

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[7] L.W. Stern, *Distribution Channels: Behavioral Dimensions*, Haughton Mifflin Company, Boston, 1969.

[8] *Ibid.*, p. 2.

[9] *Ibid.*, p. 112.

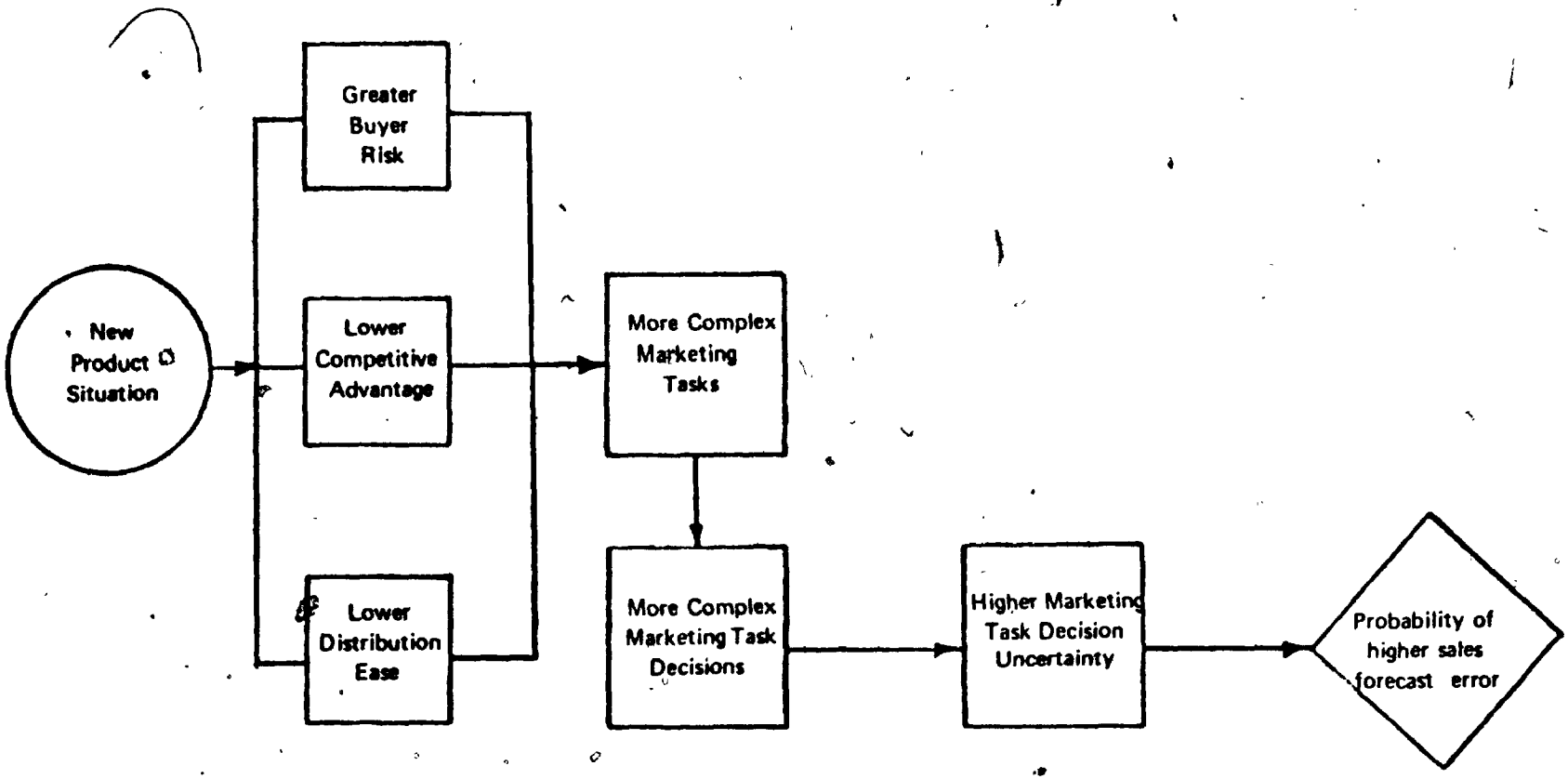

Figure 3.3

Hypothesized Relationship of Marketing Task Complexity to Sales Forecast Error.

error made by managers. A summary of the postulated relationships is provided in Table 3.1 at the end of Section 3.5.

3.5.1 Variables Describing Marketing Task Similarity

A set of eight variables define the similarity of the set of marketing tasks facing managers in a new product situation.

1. Similarity of Product Characteristics

Greater similarity of the performance characteristics of a new product is hypothesized to reduce the probability of sales forecast error. More similar product characteristics will tend to increase the similarity of the marketing tasks faced by managers, particularly the product performance task, pricing task, and personal selling task.

2. Similarity of After-Sales Service

Greater similarity of the extent and character of the after-sales service for a new product is hypothesized to reduce the probability of sales forecast error. More similar after-sales service requirements will tend to increase the similarity of the marketing tasks, particularly the personal selling task, pricing task, and competitive strategy task.

3. Similarity of Potential Buyers

Greater similarity of the potential buyers for a new product is hypothesized to reduce the probability of sales forecast error. More similar buyers for the new product will tend to increase the similarity of all the marketing tasks faced by managers.

4. Similarity of Distributors

Greater similarity of the potential distributors in the market for a new

product is hypothesized to reduce the probability of sales forecast error. More similar distributors will tend to increase the similarity of the marketing tasks particularly the personal selling task, distribution task, and competitive strategy task.

5. Similarity of Personal Selling

Greater similarity of the personal selling requirements for a new product is hypothesized to reduce the probability of sales forecast error. More similar personal selling requirements will tend to increase the similarity of the marketing tasks faced by managers, particularly the personal selling task.

6. Similarity of Advertising

Greater similarity of the advertising requirements for a new product is hypothesized to reduce the probability of sales forecast error. More similar advertising requirements will tend to increase the similarity of the marketing tasks faced by managers, particularly the advertising/promotion task.

7. Similarity of Competitors

Greater similarity of the competitors in the market for a new product is hypothesized to reduce the probability of sales forecast error. More similar competitors will tend to increase the similarity of the marketing tasks faced by managers, particularly the competitive strategy task.

8. Similarity of Product Technology

Great similarity of the technology related to a new product is hypothesized to reduce the probability of sales forecast error. More similar product technology will tend to increase the similarity of the marketing tasks, in particular the product performance task, pricing task, and competitive strategy tasks.

3.5.2 Variables Describing Marketing Task Complexity

A set of fifteen variables define the complexity of the set of marketing tasks facing managers in a new product situation. These variables describe the three constructs of buyer risk, competitive advantage, and distribution ease.

3.5.2.1 Buyer Risk

The following set of variables define the construct of buyer risk in the descriptive model.

1. Extent of After-Sale Service

A greater extent of after-sale service expected for a new product will tend to increase the purchase risk to buyers and therefore to increase the probability of sales forecast error. This variable was proposed by Fisher as a measure of commercial uncertainty to buyers.[10] A measure of this variable was also considered in the screening model of Harris.[11]

2. Purchase Importance to Buyers

Greater relative importance of purchase of a new product to potential buyers in terms of how essential the generic product is to the buyer's operation will tend to increase the purchase risk to the buyer, and therefore to increase the probability of sales forecast error. This variable was proposed by Robinson, Faris, and Wind as a measure of buyer risk.[12]

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[10] L. Fisher.

[11] J.S. Harris.

[12] P.J. Robinson, C.W. Faris, Y. Wind.

3. Technical Complexity to Buyers

Greater complexity of the product technology for a new product to the buyer will tend to increase buyer risk and therefore increase the probability of sales forecast error. This variable was proposed by Fisher as a measure of product complexity.[13]

4. Potential Product Effect on Buyer Profits

Greater potential effect of purchase of the new product on the profitability of the buyer's operation will tend to increase buyer risk and therefore increase the probability of sales forecast error. This variable was proposed by Fisher as a measure of commercial uncertainty to the buyer.[14]

5. Familiarity of Purchase Task to Buyers

Greater familiarity of potential buyers with purchase of the generic product will tend to reduce purchase risk to buyers and therefore reduce the probability of sales forecast error. This variable was proposed by Fisher as a measure of product complexity to the buyer.[15]

6. Relative Purchase Size to Buyers

Greater relative financial importance represented by purchase of a new product by the buyer will tend to increase buyer risk and therefore to increase the probability of sales forecast error. This variable was proposed by Fisher as a measure of commercial uncertainty to the buyer,[16] and was also considered by Pessemier in

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[13] L. Fisher.

[14] *Ibid.*

[15] *Ibid.*

[16] *Ibid.*

a screening model.[17]

7. Extent of Buyer Adaptation

A greater extent to which buyers would have to change their existing process or product to utilize the new product will tend to increase the risk to the buyer and therefore increase the probability of sales forecast error. This variable was proposed by Fisher as a measure of commerical uncertainty to the buyer.[18]

3.5.2.2 Competitive Advantage

The following set of variables define the construct of competitive advantage in the descriptive model.

1. Extent of Patent Protection

Greater extent of patent protection held by the firm for the new product or its components will tend to increase competitive advantage and therefore reduce the probability of sales forecast error. This variable is considered in the screening models of Pessemier,[19] Richman,[20] O'Meara,[21] and Harris.[22]

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[17] E.A. Pessemier.

[18] L. Fisher.

[19] E.A. Pessemier.

[20] B.M. Richman.

[21] J.T. O'Meara.

[22] J.S. Harris.

2. Product Uniqueness

Greater uniqueness of the performance features of the new product compared to generic competitive products will tend to increase competitive advantage and therefore reduce the probability of sales forecast error. This variable is considered in the screening models of Pessemier,[23] Richman,[24] O'Meara,[25] Harris,[26] and Wilson.[27]

3. Competitive Product Newness

Greater newness of the new product compared to competitive generic products will tend to increase competitive advantage and therefore reduce the probability of sales forecast error. Measures of this variable are considered in the screening models of Pessemier,[28] Richman,[29] O'Meara,[30] Harris,[31] and Wilson.[32]

4. Ease of Competitive Duplication

Greater ease of duplication of the new product performance features by competitors will tend to decrease competitive advantage and therefore increase

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[23]E.A. Pessemier.

[24]B.M. Richman.

[25]J.T. O'Meara.

[26]J.S. Harris.

[27]A. Wilson.

[28]E.A. Pessemier.

[29]B.M. Richman.

[30]J.T. O'Meara.

[31]J.S. Harris.

[32]A. Wilson.

the probability of sales forecast error. Measures of this variable are considered in the screening models of Pessemier,[33] O'Meara,[34] and Wilson.[35]

3.5.2.3 Distribution Ease

The following set of variables define the construct of distribution ease in the descriptive model.

1. Buyer Industry Diversity

A greater number of different industries in which potential customers for a new product are located will tend to reduce distribution ease and therefore increase the probability of sales forecast error. A measure of this variable is considered in the screening model of Pessemier.[36]

2. Importance of Distributor Support

Greater importance of the active support of potential distributors in marketing a new product will tend to reduce distribution ease and therefore increase the probability of sales forecast error. A measure of this variable is considered in the screening model of Pessemier.[37]

3. Expected Extent of Distributor Support

Greater support of the distributors in marketing a new product will tend to increase distribution ease and therefore reduce the probability of sales fore-

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[33] E.A. Pessemier.

[34] J.T. O'Meara.

[35] A. Wilson.

[36] E.A. Pessemier.

[37] *Ibid.*

cast error. A measure of this variable is considered in the screening model of Pessemier.[38]

4. Extent of Distributor Influence on Buyers

A greater extent to which distributors for a new product can influence potential buyers in their purchase of the product will tend to reduce distribution ease and therefore increase the probability of sales forecast error. A measure of this variable is considered in the screening model of Pessemier.[39]

3.6 SUMMARY OF THE DESCRIPTIVE MODEL

This section summarizes the descriptive model. An outline of the model is shown schematically in Figure 3.4. The model hypothesizes relationships between a set of predictor variables defining the model constructs and sales forecast error made by managers when screening new products. The variables define two central constructs, marketing task similarity and marketing task complexity. The construct of marketing task complexity is described by three other constructs, buyer risk, competitive advantage and distribution ease. It is hypothesized that in a new product situation, lower marketing task similarity and greater marketing task complexity will tend to increase the probability of sales forecast error. Greater buyer risk, lower competitive advantage, and lower distribution ease are hypothesized to increase marketing task complexity.

3.7 THE ANALYTIC FORM OF THE MODEL

The analytic form of the model is a multiple discriminant function.

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[38] *Ibid.*

[39] *Ibid.*

TABLE 3.1

SUMMARY OF THE EFFECTS OF PREDICTOR VARIABLES ON SALES FORECAST ERROR

VARIABLES DESCRIBING MARKETING TASK SIMILARITY		
Variable Symbol	Variable Name	Effect on Sales Forecast Error
SM_1	Similarity of product characteristics	↓
SM_2	Similarity of after-sales service	↓
SM_3	Similarity of potential buyers	↓
SM_4	Similarity of distributors	↓
SM_5	Similarity of personal selling	↓
SM_6	Similarity of advertising	↓
SM_7	Similarity of competitors	↓
SM_8	Similarity of product technology	↓

VARIABLES DESCRIBING BUYER RISK		
Variable Symbol	Variable Name	Effect on Sales Forecast Error
BR_1	Extent of after-sale service	↑
BR_2	Purchase importance to buyers	↑
BR_3	Technical complexity to buyers	↑
BR_4	Potential product effect on buyer profits	↑
BR_5	Familiarity of purchase task to buyers	↓
BR_6	Relative purchase size to buyers	↑
BR_7	Extent of buyer adaptation	↑

VARIABLES DESCRIBING COMPETITIVE ADVANTAGE		
Variable Symbol	Variable Name	Effect on Sales Forecast Error
CA_1	Extent of patent protection	↓
CA_2	Product uniqueness	↓
CA_3	Competitive product newness	↓
CA_4	Ease of competitive duplication	↑

VARIABLES DESCRIBING DISTRIBUTION EASE		
Variable Symbol	Variable Name	Effect on Sales Forecast Error
DE_1	Buyer industry diversity	↑
DE_2	Importance of distributor support	↑
DE_3	Expected extent of distributor support	↓
DE_4	Extent of distribution influence on buyers	↑

↑ indicates positive effect ↓ indicates negative effect

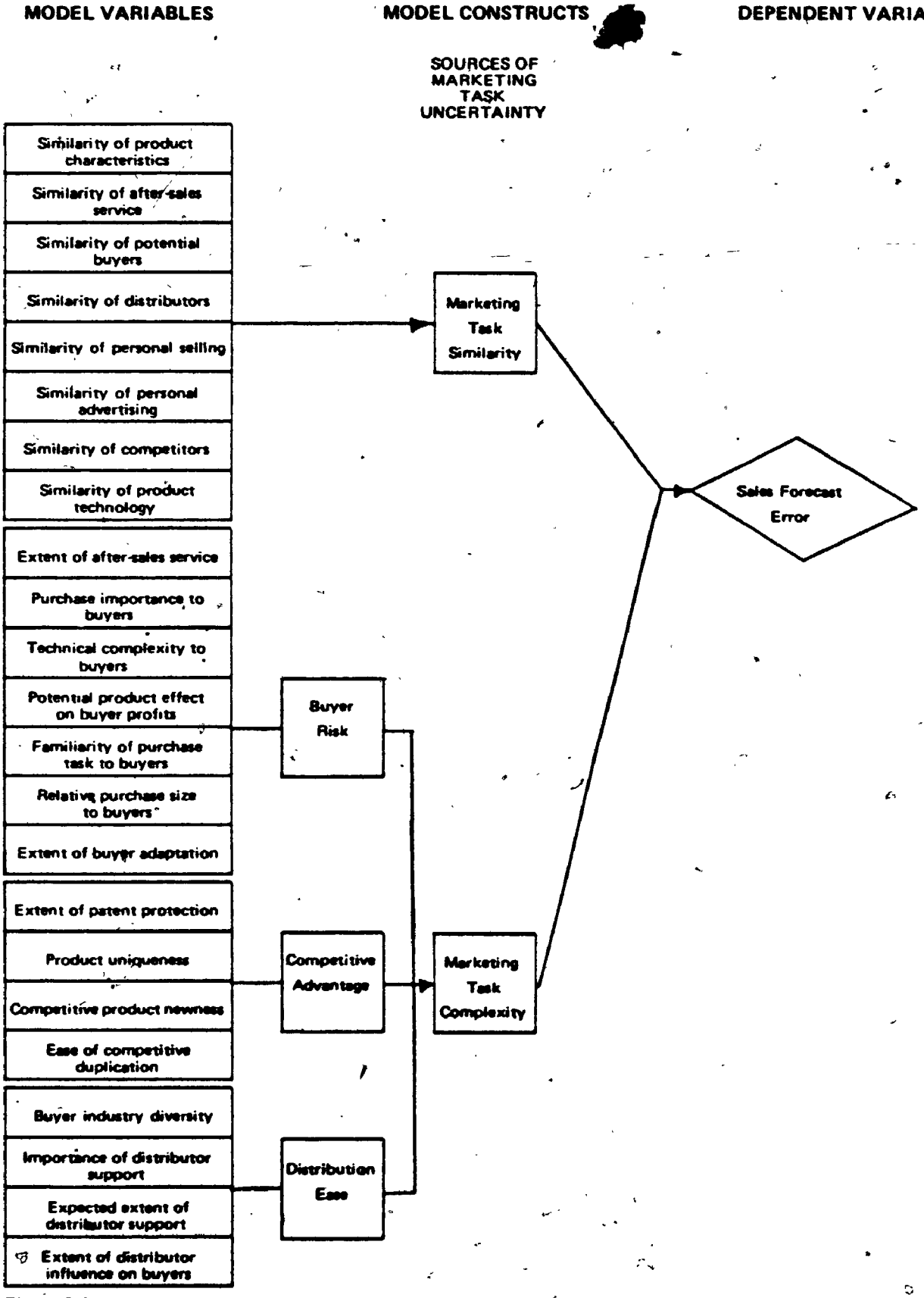

Figure 3.4
Outline of the proposed Descriptive Model

The output of the model when framed as a predictive model is consistent with a common method for expressing and evaluating sales forecast uncertainty in terms of a probability distribution. This use of the model to generate probabilities of different levels of sales forecast error is outlined in detail in Appendix C.

Two alternate mathematical forms of the model are proposed to describe the relationships between sales forecast error and the new product situational variables. These are a linear additive model and a linear multiplicative model.

The linear additive model assumes that the new product situational variables are related to sales forecast error in a linear and additive fashion:

$$P(E) = \alpha_o + \alpha_1 X_1 + \ldots \alpha_n X_n \qquad (3.1)$$

where $P(E)$ = probability of sales forecast error

α_i = model coefficients

X_i = new product situational variables.

The linear multiplicative model assumes that the new product situational variables describing the major constructs in the descriptive model are related to sales forecast error in a multiplicative fashion:

$$P(E) = \alpha_o X_1 X_2 \ldots X_n \qquad (3.2)$$

The rationale for a multiplicative model is based on two major considerations.

1. The effect of uncertain decision inputs to a decision process involving stochastic outcomes infers a probabilistic relationship between the effect of each input and the outcome. Taking the inputs together, the multiplicative nature of jointly considered inputs with uncertainty would be statistically handled by multi-

plying the probabilities of each uncertain input having the predicted effect on the outcome.

2. There is some evidence that managers handling uncertainty in unprogrammed decision-making situations do not treat criteria additively. In a study of unprogrammed decision-making in choices between multiple attribute situations, Sallberg concluded that probabilities generated by decision-makers were neither additive nor cardinally-scaled.[40] In a similar discussion of interaction among choice criteria in multiple attribute choice situations, Blalock concluded that additive models seem to approximate reality reasonably well, but suggested the use of non-additive models as alternatives when interaction between criterion was considered important.[41]

3.8 SUMMARY

This chapter has outlined the development of the hypothesized descriptive model of the research. The model hypothesizes that the probability of sales forecast error made by managers when screening a new product is related to a set of variables which describe the similarity and complexity of the marketing tasks facing them. The hypothesized relationships between the predictor variables and the probability of sales forecast error were outlined.

The descriptive model was presented and linear and multiplicative mathematical forms of the model were suggested.

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[40] P.O. Sallberg, "Unprogrammed Decision-Making," *Industrial Management Review*, 1966, p. 19.

[41] Blalock, *The American Sociological Review*, 30 (June, 1965), pp. 374-380.

CHAPTER IV

STATEMENT OF HYPOTHESES

4.1 INTRODUCTION

In Chapter IV, the main hypotheses of the research, which were developed in the two previous chapters, are summarized and restated in a more rigorous fashion. One of the objectives of the research is to investigate the relationships between sales forecast error which managers make at the screening stage of a new product development and sets of variables which influence this error. The first two sets of hypotheses focus on these relationships.

A second objective is the testing of the predictive power of the model based on the sets of variables identified in a descriptive analysis. The third hypothesis addresses this test.

4.2 HYPOTHESIS SET H_1

The descriptive model developed in Chapter III proposes that the sales forecast error made by managers when screening a new product is related to variables which describe the similarity of the marketing tasks facing the firm. The proposed relationships between sales forecast error and this set of predictor variables constitute the first set of hypotheses and are presented in Table 4.1. The hypothesis can be stated as follows;

The level of sales forecast error made by managers when screening a new product will be related to a set of variables which describe the marketing task

TABLE 4.1

HYPOTHESIS SET H_1

The level of sales forecast error in a new product introduction is related to:			
Hypothesis Number	Variable Symbol	Variable Name	Hypothesized Effect
$H_{1.1}$	SM_1	Similarity of product characteristics	Negative
$H_{1.2}$	SM_2	Similarity of after-sale service	Negative
$H_{1.3}$	SM_3	Similarity of potential buyers	Negative
$H_{1.4}$	SM_4	Similarity of distributors	Negative
$H_{1.5}$	SM_5	Similarity of personal selling	Negative
$H_{1.6}$	SM_6	Similarity of personal advertising	Negative
$H_{1.7}$	SM_7	Similarity of competitors	Negative
$H_{1.8}$	SM_8	Similarity of product technology	Negative

similarity of the new product situation facing the managers compared to the existing products of the firm.

Mathematical representations of the descriptive model were also postulated. These include both additive and multiplicative models relating sales forecast error to the hypothesized variables.

4.3 HYPOTHESIS SET H_2

The model also proposes that the sales forecast error made by managers is related to variables which describe the complexity of the marketing tasks facing the firm by describing three constructs which influence complexity, buyer risk, competitive advantage, and distribution ease. The proposed relationships between sales forecast error and this set of predictor variables constitute the second set of hypotheses and are presented in Table 4.2. This hypothesis can be stated as follows;

The level of sales forecast error made by managers when screening a new product will be related to a set of variables which describe the marketing task complexity of the new product situation facing the firm.

4.4 HYPOTHESIS H_3

Hypothesis H_3 addresses the predictive ability of a discriminant model based on the set of significant variables from the descriptive analysis and hypothesis testing. The hypothesis can be stated as follows;

The model based on the set of predictor variables describing marketing task similarity and complexity can significantly predict probabilities of different levels of sales forecast error in new product situations.

TABLE 4.2

HYPOTHESIS SET H_2

The level of sales forecast error in a new product introduction is related to:			
Hypothesis Number	Variable Symbol	Variable Name	Hypothesized Effect
		BUYER RISK	
$H_{2.1}$	BR_1	Extent of after sale service	Positive
$H_{2.2}$	BR_2	Purchase importance to buyers	Positive
$H_{2.3}$	BR_3	Technical complexity to buyers	Positive
$H_{2.4}$	BR_4	Potential effect on buyer profits	Positive
$H_{2.5}$	BR_5	Familiarity of purchase task to the buyer	Negative
$H_{2.6}$	BR_6	Relative purchase size to buyers	Positive
$H_{2.7}$	BR_7	Extent of buyer adaptation	Positive
		COMPETITIVE ADVANTAGE	
$H_{2.8}$	CA_1	Extent of patent protection	Negative
$H_{2.9}$	CA_2	Product uniqueness	Negative
$H_{2.10}$	CA_3	Competitive product newness	Negative
$H_{2.11}$	CA_4	Ease of competitive duplication	Positive
		DISTRIBUTION EASE	
$H_{2.12}$	DE_1	Buyer industry diversity	Positive
$H_{2.13}$	DE_2	Importance of distributor support	Positive
$H_{2.14}$	DE_3	Expected extent of distributor support	Negative
$H_{2.15}$	DE_4	Extent of distributor influence on buyers	Positive

CHAPTER V

RESEARCH METHODOLOGY

5.1 INTRODUCTION

The previous chapter presented the three hypotheses of the research, which concern the level of sales forecast error made by managers when screening new products for development. The present chapter reports the research methodology used to test these hypotheses. The data collection phase is first described in terms of the sample and the methods of data measurement and collection. The plan for analysis of the data is then outlined. The data analysis techniques employed and the rationale for selecting these particular analytical methods are outlined. The chapter concludes with a discussion of the major limitations of the data.

5.2 THE RESEARCH DATA

A large number of new product projects undertaken by firms were studied in order to test the hypotheses. The sample of firms and projects as well as the measures of the variables for the present research existed in the form of a data bank. This data bank was developed over a period of several years as part of an on-going study into the development of industrial new products in Canada.[1] The data for the present research were obtained during personal interviews with managers and in short-answer mailed questionnaires.

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[1] An outline of this ongoing study is given in: B. Little, R.G. Cooper and R.A. More, "The Assessment of Markets for the Development of New Industrial Products in Canada," *Working Paper No. 62, School of Business Administration, The University of Western Ontario*, December, 1971.

The sample of firms was selected from a population of Canadian industrial goods manufacturers located in Ontario and Quebec which were known to be active in new product development.[2] While the sample included firms of all sizes and from many industries, it excluded certain industries (such as industrial services and natural resource firms) whose new product development activities were thought to be limited, and also tended to be weighted toward larger firms to reflect the number of projects associated with larger firms versus smaller firms.

Personal interviews were conducted during the summers of both 1971 and 1972 in 152 firms with the manager or managers most involved with the firm's new product development activities from a marketing viewpoint. In both cases, the personal interviews lasted from two to four hours and were based on a lengthy questionnaire. Data were sought at two levels; information about the company in general, and also data on two specific new product projects, one which was relatively successful, and one which was relatively unsuccessful. The manager(s) endeavoured to select new product projects with which he was quite familiar. The project was also as typical as possible to his firm and had been undertaken during the prior five year period. A number of questions were posed to characterize the new product situation, and to describe the development activities undertaken during the project.

In total, 264 new product situations were studied from the sample of 152 firms. The sample of projects ultimately analysed in this study totaled 185 new product ventures, a subset of the original 264 projects which were mass-market new product situations. Projects were lost from the subsample of mass-market situations for a number of reasons. A dozen firms had either ceased operations or no longer wished to participate in the study. Other projects were deleted because of sub-

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[2]The main source of the population of firms was Government of Canada, Department of Industry, Trade, and Commerce, *Directory of Scientific Research and Development Establishments in Canada* (1969). Other private lists of firms supplemented the population.

stantial missing data; managers could not or would not provide certain interview data, or did not return the mail-back questionnaire. A description of the resulting sample of firms by industry and company size is presented in Table B.4, Appendix B. While neither the sample of firms nor the selection of projects within firms is truly random, no major biases were evident in the sample, and it is reasonable to assume that the research results may be generalized with caution to other Canadian new product ventures.

The dependent variable in the study, sales forecast error, was measured as part of the personal interview questionnaire. The questionnaire items used for the measurement are outlined in Part A.1 of Appendix A.

5.3 DATA ANALYSIS

In this section, the methods utilized to analyze the research data are described,[3] and the appropriateness of each technique to the research is discussed. Figure 5.1 provides an outline of the sequence of analyses undertaken to test the hypotheses. The analysis of the data will be outlined in terms of this sequence.

5.3.1 Exploring Predictor Variable Associations

The set of predictor variables in the descriptive model define the central constructs of the model. Simple correlation analysis was used to identify the relationships among predictor variables. Factor analyses of the predictor variables were carried out to examine the internal consistency of the major constructs. Three sets of factor analyses were undertaken, the first to explore the two major constructs in the model, marketing task similarity and marketing task complexity. The

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[3]All data analysis was undertaken using programs from *Biomedical Computer Programs*, W.J. Dixon, Editor, University of California Press, Berkeley, California.

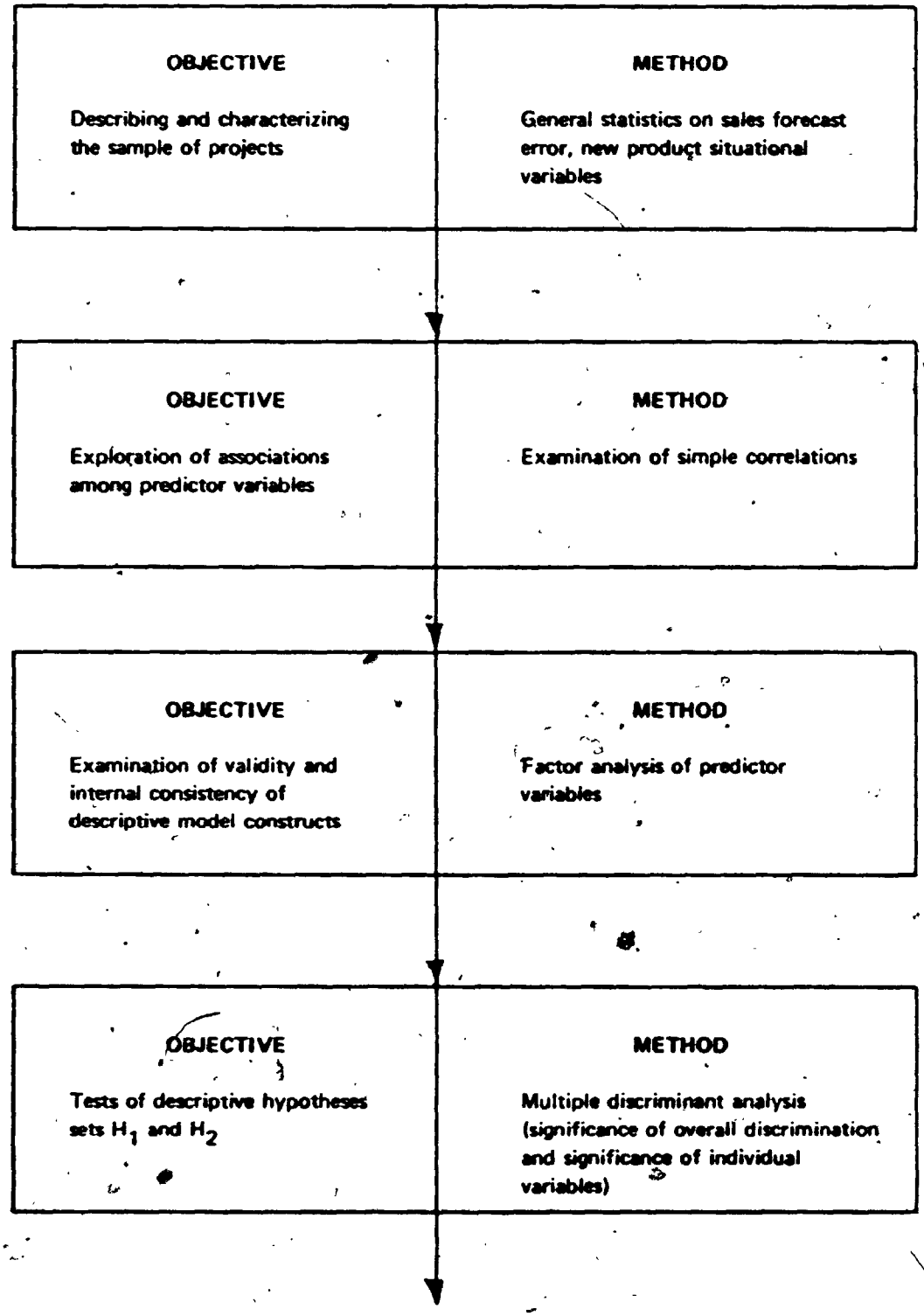

Figure 5.1
The Data Analysis Plan

OBJECTIVE	METHOD
Determination of the set of most significant discriminating predictors	Multiple discriminant analysis for the additive model (significance of individual variables)
OBJECTIVE	**METHOD**
Selection of the best descriptive model	Highest significance of discrimination between the additive and multiplicative models
OBJECTIVE	**METHOD**
Tests of predictive hypothesis H_3	Discriminant analysis with random sample correction for bias Discriminant analysis with split sample (significance of percent correctly classified)

Figure 5,1 (continued)
The Data Analysis Plan

second factor analysis explored the three constructs which define marketing task complexity, buyer risk, competitive advantage, and distribution ease. The final factor analysis explored the total number of factors which could describe the complete set of 23 predictor variables.

A parallel application of factor analyses has been suggested in order to identify more complex variables from the many that comprise a screening checklist.[4]

5.3.2 Testing the Descriptive Hypotheses

The two sets of descriptive hypotheses were tested using evidence from both the additive and multiplicative forms of the model. Multiple discriminant analysis applied to these models provides for testing of the significance of both individual predictor variables and sets of predictor variables which define the constructs in the descriptive model.

5.3.2.1 Hypotheses Set H_1

The first hypothesis set focuses on the relationships between a single continuous dependent variable, sales forecast error, and a set of variables which describe the similarity of the marketing tasks facing the firm;

$$E = f(X_1, X_2, X_3 \ldots\ldots X_n) \qquad (5.1)$$

where X_i are the predictor variables describing marketing task similarity

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[4] A.D. Shocker, D. Gensch, L.S. Simon, "Toward the Improvement of New Product Search and Screening," in *Product Planning*, edited by A.E. Spitz, Auerbach, New York, 1972, p. 162.

E is the level of sales forecast error.

Multiple discriminant analysis was used to relate the dependent variable, sales forecast error, to the group of hypothesized predictor variables in order to test the first set of hypotheses. Discriminant analysis provides a measure of the degree of association between the dependent variable and each predictor variable, and also describes the nature of the relationships. The resulting best fit discriminant functions provide a descriptive relationshp, and with appropriate corrections, a predictive relationship between dependent and predictor variables.

In discriminant analysis, there are two sets of assumptions, those pertaining to the nature of the dependent and predictor variables, and those pertaining to the analytic purpose of the discriminant analysis technique.

In discriminant analysis, the dependent variable is normally assumed to be nominal or ordinal in nature. In this research, the dependent variable measure of sales forecast error was a ratio-scaled variable expressed as an ordinal measure. The set of predictor variables are normally assumed to be interval-scaled measures. In this research, the predictor variable measures were ordinal-scaled measures. Pretesting of the scales gave some indication that the interval assumption was not extreme.[5] To the extent this assumption was violated, its only effect was to attenuate the results of the analysis. The use of multiple discriminant analysis with non-interval

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[5]The scales used to measure the predictor variables were pretested for their ordinal nature using a card-ranking procedure on a sample of doctoral students at the School of Business Administration, The University of Western Ontario. Rank errors were confined to three particular questions, which were revised. The scales were also tested for their closeness to interval scales using the same sample of students using measurement of perceived intervals between scale points.

predictor variables has been demonstrated in other research.[6]

The set of analytic assumptions depend upon the analytic objectives of linear discriminant analysis that are to be utilized. The use of the analysis involves addressing four possible objectives.[7]

1. Testing whether significant differences exist among the average score profiles of two or more a prior defined groups.

2. Determining which variables account most for such intergroup differences in average profile.

3. Finding linear combinations of the predictor variables that enable the analyst to represent the groups by maximizing among-group to within-group separation.

4. Establishing procedures for assigning new individuals whose profiles, but not group identity, are assumed to be from one of the a priori defined groups.

For the first three objectives, which are descriptive in nature, the following assumptions must be made:

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[6]See for example; W.T. Anderson, Jr. and W.H. Cunningham "The Socially Conscious Consumer," *Journal of Marketing*, Vol. 36 (July, 1972), pp. 23-31; W.F. Massy, "Discriminant Analysis of Audience Characteristics," *Journal of Advertising Research*, Fall, 1965; T.S. Robertson and J.N. Kennedy, "Prediction of Consumer Innovators: Application of Multiple Discriminant Analysis," *Journal of Marketing Research*, Vol. V. February, 1968, pp. 64-69; and W.F. Massy, "Analyzing Product Profiles with Orthogonal Discriminant Functions," *Journal of the American Statistical Society*, Conference Proceedings, 1966.

[7]P.E. Green, D.S. Tull, *Research for Marketing Decisions*, second edition, Prentice-Hall, 1970, p. 369.

- Covariation and dispersion of the predictor variables are equal for both groups, that is the covariance matrices of the predictor variables for the two groups are the same.[8]

- The distribution of the predictor variables are multinormal. This can be tested by examination of the individual variable distributions.

The first two hypotheses sets, H_1 and H_2, are descriptive in nature and involve making these first two assumptions. For the last hypothesis, which is predictive in nature, two additional assumptions must be made:

- Equal probabilities of a sample point's belonging to each of a set of a priori defined groups. This is a function of the sizes of the two groups on which the classification criteria was evaluated. If these groups were not equal in size, the unequal probabilities can be corrected for.[9]

- Equal costs of misclassification of a sample point from one group into the other group.

Testing of the first hypothesis set began with classification of the 185 new product situations into groups on the basis of the level of sales forecast error. These groups were chosen so as to be as close to equal size as possible in order to meet the third analytical assumption. The discriminant function coefficients were then evaluated. The extent of discrimination between the groups made by the set of predictor variables for both the additive and multiplicative models was tested using an F statistic derived from the Maholanobis D^2 statistic.[10] The significance of

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[8] D.G. Morrison, "On the Interpretation of Discriminant Analysis," *Journal of Marketing Research*, Vol. VI, May 1969, p. 162.

[9] *Ibid.*

[10] For details of this transformation, refer to: C.R. Rao, *Linear Statistical Inference and Its Applications*, John Riley and Sons, 1965, p. 482.

individual predictor variables in the discrimination was tested using a generated F statistic from the analysis of the additive model. The significance of each individual predictor variable could not be examined for the multiplicative model since the multiplicative indices are derived from the entire set of variables.

5.3.2.2 Hypothesis Set H_2

The second hypothesis set H_2 focuses on the relationship between sales forecast error and a set of variables which describe the complexity of the marketing tasks facing the firm. This hypothesis was tested using the same sequence of analyses as hypothesis set H_1.

5.3.3 Testing Predictive Hypothesis H_3

The predictive hypothesis of the research was tested using two approaches.[11] The criterion for evaluating the predictive power of a discriminant function is the percent correctly classified criterion, which can be tested for statistical significance using a t statistic.[12]

The percent correctly classified criterion is evaluated as part of a discriminant analysis. However, use of this method to evaluate predictive ability can result in an upward bias in the criterion if the discriminant coefficients from one sample are used to compute the percent correctly classified on the same sample. This bias can be corrected by two approaches, the first by using a simulated sample

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[11]This procedure is suggested by R.E. Frank, W.F. Massy, D.G. Morrison, "Bias in Multiple Discriminant Analysis," *Journal of Marketing Research*, Vol. II (August, 1965), pp. 250-258.

[12]W.T. Anderson, W.H. Cunningham, p. 28.

approach which is based on the use of a synthetic validation sample. The synthetic sample consists of randomized data, for which no real differences among populations exist. The discriminatory power given by the synthetic sample classification matrix can be interpreted as a measure of the bias. This approach was used as the first test of predictive hypothesis H_3.

The second approach used to test the predictive hypothesis was based on a split sample approach, which consisted of splitting the original sample and seeing how well the discriminant coefficients estimated from one subsample could predict the group to which each member of the other subsample belongs.

5.4 LIMITATIONS OF THE DATA

This section outlines the most important limitations faced in gathering the research data and the approaches taken to overcome them.

5.4.1 Respondent Obstacles

Respondent obstacles refers to problems that are characteristic of most field research involving a respondent's perception of a past situation.

5.4.1.1 Lack of Knowledge

The knowledge the respondent has of the particular new product situation will influence his perception of the variable measures used in the research. The sample of managers for this research was drawn from companies researched in a former study,[13] and liason with these companies made it possible to survey respon-

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[13] B. Little, R.G. Cooper, R.A. More.

dents that had good familiarity with the new product situation being studied.

5.4.1.2 Reporting Bias

The data gathered in this research represented two different points in time over the development period of the new product situations involved. These points in time may have been separated by as little as one month or as much as three years. The manager was asked in the research to scale the situational variables as if he were back at the point in time when the idea was first proposed. Response of the manager may have been biased by both the actual outcomes of the project and information acquired by managers as they proceeded with the new product development. The manager may be reflecting his current view of the new product situation rather than his view of the situation at the time it was first proposed. The following steps were taken to minimize this problem; firstly the situational variables were operationally defined in the questionnnaire to be as free of time bias as possible. Secondly, the instructions to the respondent managers placed great emphasis on trying to measure the perception at the prior point in time.

5.4.2 Data Obstacles

5.4.2.1 The Subjective Nature of the Predictor Variables

The situational variables have been characterized as qualitative variables. This necessitated an ordinal scaling method to measure the variables, and introduced the problem of varying perceptions of the variable scales by different respondents. To the extent this perception varied, the reliability of this data was reduced, and hence the validity. The method of addressing this problem was to have

several respondents in the same firm scale the same new product situation and examine the variance in their responses. This was done as part of the pre-testing of the research questionnaire. This procedure, unfortunately also measured differences in the respondent's perceptions of the situations as well as the scales, but separating the two was virtually impossible.

5.5 SUMMARY

Chapter V has outlined the methodology utilized to test the hypotheses of the research. A description of the sample of firms and new product projects was presented.

The nature of the set of predictor variables suggested that correlation analysis and factor analysis were useful analytic tools to explore associations among the predictor variables and to validate the constructs postulated in the descriptive model. Multiple discriminant analysis was presented as an appropriate analytic technique for development of the model and hypothesis-testing, having a form consistent with management representation of the uncertainty of their sales forecasts.

The discussion of the limitations of the data suggested that the measures of variables, in spite of some limitations, were reasonable, given the nature of the research topic and the resources available to carry out the research.

CHAPTER VI

MAJOR EMPIRICAL FINDINGS

6.1 INTRODUCTION

This chapter reports the major empirical findings of the research. The descriptive sales forecast error model formulated in Chapter III generated two descriptive hypothesis sets which hypothesize that the level of sales forecast error made by managers when screening a new product is influenced by variables which describe two constructs, marketing task similarity and marketing task complexity. A predictive hypothesis was made that the descriptive model could predict sales forecast error probabilities at the screening stage of new product situations. Chapter V outlined the methodology of the research to test these hypotheses. The present chapter reports the results of these analyses.

This chapter begins with a brief discussion of the general characteristics of the sample that help to describe the 185 new product situations studied. Next, associations between predictor variables are explored through examination of simple correlations. A factor analytic approach is utilized to examine the consistency of the major constructs hypothesized in the descriptive model. Testing of the two descriptive hypothesis sets follows, utilizing a number of related discriminant analytic tests for both the additive and multiplicative models proposed. The significance of each variable and the sets of variables which comprise the major constructs in the model are discussed. Next, the best descriptive model is utilized for testing of the

predictive hypothesis. The tests of the analytical assumptions are outlined. The chapter concludes with a summary of the findings of the research.

6.2 GENERAL STATISTICS

6.2.1 Sales Forecast Error

Absolute sales forecast error reflects both positive error (sales higher than forecast) and negative error (sales lower than forecast). The range in absolute error was very high, from 0 percent to 899 percent. The mean absolute sales forecast error for the sample was 51.9 percent, whereas the median error was 35 percent, indicating that the distribution of absolute error is skewed to the right. This indicates that a large number of managers made extremely high errors in their sales estimates. When managers did make some sales forecast error ($E>0$) in new product situations, the error tended to be very large. The mean error given that $E>0$ was 81 percent. For all the new product situations in the sample, 41.7 percent had sales forecast error greater than 50 percent.

The relatively small percentage of new product situations (14.2 percent) with sales forecast error greater than zero but less than 50 percent suggests an approximately bimodal distribution of the dependent variable which improves the appropriateness of a two-way discriminant analysis. The greater the modality of the dependent variable distribution, the more closely the analytical assumption of a nominal dependent variable is approached.

It is interesting to note that for a large number of new product situations, (36.2 percent) managers stated a zero error level. It is doubtful in fact

if this percentage of situations actually had absolutely no error in sales forecasts, although likely that the errors were relatively low. In terms of the research data measurement, most of these cases were those in which managers had not recorded estimates of sales at the screening stage and had to make an estimate of their sales forecast error. The frequency of different levels of absolute sales forecast error is shown in Table 6.1.

Managers made negative sales forecast errors far more frequently than positive errors. While 12.9 percent of the new product situations had positive errors, 50.9 percent had negative errors. This finding is consistent with evidence of manager's systematic upward bias in sales forecasts for new products reported by Tull.[1]

It is significant that in the 94 new product situations where negative error was made, 64 cases or 68 percent had error in excess of 50 percent. When managers made negative errors in sales forecast, the majority made extremely high errors. The frequency of different levels of positive and negative sales forecast error is shown in Table 6.2.

These findings on sales forecast error indicate the difficulty managers experience in forecasting sales for new products at the screening stage of their development. The magnitude of the errors made and the high incidence of negative error point to the importance of managers improving their evaluation of the uncertainty attached to this forecast variable.

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[1] D.S. Tull, "The Relationship of Actual and Predicted Sales and Profits in New-Product Introductions," *The Journal of Business*, Vol. 40, No. 3 (July, 1967), p. 233.

TABLE 6.1

FREQUENCY OF DIFFERENT LEVELS OF ABSOLUTE SALES FORECAST ERROR (N=185)

Error, percent[a]	Frequency	Percentage of total[b]	Cumulative Percentage
$E = 0$	67	36.2	36.2
$0 < E \leq 10$	5	2.7	38.9
$10 < E \leq 20$	10	5.4	44.3
$20 < E \leq 30$	7	3.8	48.1
$30 < E \leq 40$	6	3.2	51.3
$40 < E \leq 50$	13	7.0	58.3
$50 < E \leq 70$	11	5.9	64.2
$70 < E \leq 100$	59	31.9	96.1
$100 < E \leq 200$	1	0.6	96.7
$E > 200$	6	3.3	100.0
Total	185	100.0	

[a]Percent error was calculated using the following formula:

$$E = \left| \frac{\text{Actual unit sales} - \text{Forecast unit sales}}{\text{Forecast unit sales}} \right| \times 100$$

[b]Percentages may not sum to 100.0 due to rounding errors.

TABLE 6.2

FREQUENCY OF LEVELS OF SALES FORECAST ERROR
(N=185)

Error, percent[a]	Frequency	Percentage of total[b]	Cumulative Percentage
$E < -50$	64	34.6	34.6
$-50 \leq E < -20$	18	9.7	44.3
$-20 \leq E < 0$	12	6.6	50.9
$E = 0$	67	36.2	87.1
$0 < E \leq 20$	3	1.6	88.7
$20 < E \leq 50$	8	4.3	93.0
$E > 50$	13	7.0	100.0
Total	185		

[a]Percentage error was calculated using the following formula;

$$E = \frac{\text{Actual unit sales} - \text{Forecast unit sales}}{\text{Forecast unit sales}} \times 100$$

[b]Percentages may not sum to 100.0 due to rounding errors.

6.3 EXPLORING ASSOCIATIONS BETWEEN THE PREDICTOR VARIABLES

Analysis of sets of predictor variables using simple correlation and a factor analytic approach revealed many significant associations.

6.3.1 Intercorrelations

An examination of the correlation matrix of hypothesized predictor variables indicated the existence of a large number of significant associations: every variable was significantly related ($r \geq 0.15$) to one or more other predictor variables, and in some cases to more than ten other predictor variables. However, with few exceptions, these associations were not so strong as to seriously affect the validity of the discriminant analysis results.[2]

6.3.1.1 Marketing Task Similarity Variables

The number of significant correlations among the set of variables defining the construct of marketing task similarity was high. All of the intercorrelations were positive, a situation which was consistent with the postulated model. This finding indicates that new product situations which were similar to the firms existing business tended to be similar in more than one of the eight marketing tasks. It would appear that in many cases, firms that developed a new product similar to their

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[2] Highly collinear predictor variables are undesirable in discriminant analysis; the discriminant function coefficients tend to become unstable in both magnitude and sign. The critical level of intercorrelation between predictors is not clearly documented. D.G. Morrison noted "if two independent variables are highly correlated e.g., r = .95, only one of these variables should be included in the analysis. (D.G. Morrison, "On the Interpretation of Discriminant Analysis," *Journal of Marketing Research*, Vol. VI (May 1969), pp. 56-63.)

existing products often tended to market them to existing customers through existing channels of distribution against competitors.

The correlation matrix for the marketing task similarity variables is shown in Table 6.3.

6.3.1.2 Marketing Task Complexity Variables

As with the marketing task similarity variables, a large number of associations are evident. Rather than explore the entire set of individual intercorrelates, it was more revealing to explore the sets of intercorrelates which describe the postulated model constructs describing marketing task complexity; buyer risk, competitive advantage, and distribution ease.

The correlation matrix of variables defining buyer risk is outlined in Table 6.4. Of the 21 correlations, 19 were in a direction consistent with that suggested by the model. New product situations which represented higher risk to the buyer tended to show this for more than one variable. Situations which indicated greater extent of after-sale service also tended to have greater purchase importance to the buyer, greater technical complexity to the buyer, greater potential effect on buyer profits, lower familiarity of the purchase task to buyers, greater relative purchase size to the buyer, and greater extent of buyer adaptation. Situations which indicated greater purchase importance to the buyer also tended to have greater technical complexity to the buyer, greater potential effect on buyer profits, and greater relative purchase size to the buyer.

Situations which indicated greater technical complexity to the buyer,

TABLE 6.3

MATRIX OF CORRELATION COEFFICIENTS:
MARKETING TASK SIMILARITY
VARIABLES (N = 185)

Variable	Name	Correlation Coefficients
		SM_1 SM_2 SM_3 SM_4 SM_5 SM_6 SM_7 SM_8
SM_1	Similarity of product characteristics	1.0
SM_2	Similarity of after-sales service	0.41 1.0
SM_3	Similarity of potential buyers	0.35 0.39 1.0
SM_4	Similarity of distributors	0.20 0.25 [0.53] 1.0
SM_5	Similarity of personal selling	0.37 [0.62][a] 0.45 0.32 1.0
SM_6	Similarity of advertising	0.29 [0.55] 0.49 0.36 [0.69] 1.0
SM_7	Similarity of competitors	0.35 0.41 0.39 0.23 0.48 0.36 1.0
SM_8	Similarity of product technology	0.39 0.35 0.24 0.15 0.29 0.21 0.26 1.0

[a]Correlation coefficients shown in rectangular boxes are those where $r \geq 0.5$, that is where the percentage of variance in each of the variables explained by each other is $\geq 25\%$.

TABLE 6.4

MATRIX OF CORRELATION COEFFICIENTS: MARKETING TASK COMPLEXITY VARIABLES[a]

Variable	Name	Correlation Coefficients													
		BR_1	BR_2	BR_3	BR_4	BR_5	BR_6	BR_7	CA_1	CA_2	CA_3	CA_4	DE_1	DE_2	DE_3	DE_4
	BUYER RISK															
BR_1	Extent of after-sale service	1.0														
BR_2	Purchase importance to buyers	.17	1.0													
BR_3	Technical complexity to buyers	.25	.21	1.0												
BR_4	Potential effect on buyer profit	.29	.20	.25	1.0											
BR_5	Familiarity of purchase task to buyers	.26	-.00	.35	.26	1.0										
BR_6	Relative purchase size to buyers	.34	.16	.37	.31	.37	1.0									
BR_7	Extent of buyer adaptation	.19	-.07	.29	.29	.56	.27	1.0								
	COMPETITIVE ADVANTAGE															
CA_1	Extent of patent protection	-.23	-.00	-.19	-.29	-.29	-.16	-.28	1.0							
CA_2	Product uniqueness	.19	.04	.41	.31	.38	.25	.38	-.37	1.0						
CA_3	Competitive product newness	.23	-.02	.15	.21	.41	.06	.37	-.33	.57	1.0					
CA_4	Ease of competitive duplication	-.24	-.06	-.33	-.14	-.25	-.21	-.29	.33	-.45	-.33	1.0				
	DISTRIBUTION EASE															
DE_1	Buyer industry diversity	-.04	-.03	.02	.08	.13	-.11	-.00	-.07	-.09	.06	-.08	1.0			
DE_2	Importance of distributor support	.06	.02	-.01	-.02	.08	-.06	-.05	.06	-.06	.10	-.02	.00	1.0		
DE_3	Expected extent of distributor support	-.09	-.07	-.06	-.19	.04	-.17	-.03	-.13	-.16	-.01	.06	.01	.58	1.0	
DE_4	Extent of distributor influence on buyers	.04	.04	-.03	-.00	.08	-.00	-.06	-.09	-.04	.08	-.00	.01	.91	.48	1.0

[a]Correlation coefficients shown in boxes are those where $r \geq .50$

also tended to have greater potential effect on buyer profits, greater familiarity of the purchase task to the buyer, greater relative purchase size to the buyer, and greater extent of buyer adaptation. Situations which indicated greater potential effect on buyer profits also tended to have greater familiarity of the purchase task to the buyer, greater relative purchase size to the buyer, and greater extent of buyer adaptation.

Situations which indicated lower familiarity of the purchase task to the buyer also tended to have greater relative purchase size to the buyer and greater extent of buyer adaptation. Situations which indicated greater relative purchase size to the buyer also tended to have greater extent of buyer adaptation.

These findings on the variables which define buyer risk give a good indication of the internal consistency of the construct.

The correlation matrix of variables defining competitive advantage is also outlined in Table 6.4. The directions of the intercorrelations were all consistent with that suggested by the model. In the new product situation studied, those that indicated greater product uniqueness also tended to have greater extent of patent protection, lower ease of competitive duplication, and greater competitive product newness. Situations which indicated greater extent of patent protection also tended to have lower ease of competitive duplication and greater competitive product newness. Situations that indicated greater ease of competitive duplication also tended to have lower competitive product newness.

These correlations provide evidence of internal consistency among the set of variables defining competitive advantage.

The correlation matrix of variables defining distribution ease is also outlined in Table 6.4. All the intercorrelations were consistent with the hypothesized model. New product situations that indicated greater buyer industry diversity also tended to have greater importance of distribution support, lower expected extent of distribution support, and greater extent of distribution influence in buyers. Situations that indicated greater importance of distribution support also tended to have lower expected extent of distribution support and greater extent of distribution influence on buyers. Situations that indicated lower expected extent of distribution support also tended to have greater extent of distribution influence on buyers.

These findings provide some support for the internal consistency for the construct of distribution ease.

6.3.2 Factor Analysis of the Predictor Variables

Factor analyses of the entire set of predictor variables were carried out to further explore the associations among the predictor variables and to examine the consistency of the factors resulting with the constructs postulated in the model.

The results of an initial factor analysis are shown in Table 6.5. Two factors were derived in this analysis to explore the consistency of the two major constructs postulated in the model, marketing task similarity and marketing task complexity. The results of this factor analysis reasonably support the two postulated constructs. As shown in Table 6.5, factor F_1 emerged as a marketing task complexity factor, with 11 out of 15 marketing task complexity variables individually significant in their factor loadings. Factor F_2 emerged as a marketing task similarity factor, with 6 out of 8 marketing task similarity variables significant as above.

TABLE 6.5

RESULTS OF FACTOR ANALYSIS: TWO FACTORS[a], PRINCIPAL COMPONENTS SOLUTION

	Variable Name	VARIMAX ROTATED FACTOR MATRIX[b] FACTORS F_1	F_2	Communalities[c]
	MARKETING TASK SIMILARITY			
SM_1	Similarity of product characteristics	-0.45[d]	-0.39	0.36
SM_2	Similarity of after-sales service	-0.46	-0.53	0.49
SM_3	Similarity of potential buyers		-0.67	0.47
SM_4	Similarity of distributors		-0.76	0.57
SM_5	Similarity of personal selling	-0.32	-0.64	0.52
SM_6	Similarity of advertising	-0.21	-0.63	0.44
SM_7	Similarity of competitors	-0.27	-0.45	0.28
SM_8	Similarity of product technology	-0.32	-0.28	0.18
	BUYER RISK			
BR_1	Extent of after-sales service	0.41	0.18	0.21
BR_2	Purchase importance to buyers			0.03
BR_3	Technical complexity to buyers	0.59		0.38
BR_4	Potential effect on buyer profit	0.44		0.19
BR_5	Familiarity of purchase task to buyers	0.56	0.42	0.49
BR_6	Relative purchase size to buyers	0.50		0.25
BR_7	Extent of buyer adaptation	0.59	0.16	0.37
	COMPETITIVE ADVANTAGE			
CA_1	Extent of patent protection	-0.50		0.25
CA_2	Product uniqueness	0.69	0.18	0.52
CA_3	Competitive product newness	0.47	0.26	0.29
CA_4	Ease of competitive duplication	-0.57	-0.21	0.37
	DISTRIBUTION EASE			
DE_1	Buyer industry diversity		0.17	0.04
DE_2	Importance of distributor support	-0.38	0.66	0.58
DE_3	Expected extent of distributor support	-0.43	0.48	0.42
DE_4	Extent of distributor influence on buyers	-0.37	0.65	0.56

[a] Two factors were forced in the analysis; these are denoted factors F_1 and F_2.

[b] The values of the rotated factor matrix indicate the loadings of each variable on each of the two forced factors. For example, reading across the first row: Similarity of product characteristics = $-0.45\ F_1 - 0.39\ F_2$.

[c] Communalities indicate the percent variance of each variable explained by the two factors. For example, the two factors explain 36 percent of variations in Similarity of product characteristics but only 3% of variations in Purchase importance to buyers.

[d] The rectangular boxes indicate the highest significant factor loading on a particular variable.

Communalities for most variables were low indicating a loss of information in the reduction of variables to principle components based on two factors.

The results of a second factor analysis are shown in Table 6.6. Four factors were forced in this analysis to explore the consistency of the four constructs postulated in the model; marketing task similarity, buyer risk, competitive advantage, and distribution ease. Table 6.7 summarizes the variables with maximum loading on each of the four factors.

Factor F_2 emerged as a distribution ease factor. All of the predictor variables related to distribution had maximum loadings on this factor.

Factor F_3 emerged as a marketing task similarity factor. Of the eight variables describing marketing task similarity, seven had maximum loading on this factor.

Factor F_4 emerged as a buyer risk factor. Of the seven variables describing buyer risk, four had maximum loading on this factor.

Factor F_1 did not emerge clearly related to one construct, but rather emerged as a mixed competitive advantage – buyer risk factor. Of the seven variables with maximum loading on these factors, all four of the variables describing competitive advantage and three of the variables describing buyer risk were represented.

A further factor analytic run was made in order to determine the total number of factors that would emerge and the nature of the mixed factor from the previous factor analysis. The results of this factor analysis are shown in Table 6.8. The variables with the highest significant loading on each factor are shown in Table 6.9.

TABLE 6.6

RESULTS OF FACTOR ANALYSIS: FOUR FACTORS[a], PRINCIPAL COMPONENTS SOLUTION

	Variable Name	VARIMAX ROTATED FACTOR MATRIX FACTORS F_1	F_2	F_3	F_4	Communalities
	MARKETING TASK SIMILARITY					
SM_1	Similarity of product characteristics	-0.36		0.53		0.42
SM_2	Similarity of after-sales service	-0.23		0.74		0.61
SM_3	Similarity of potential buyers		-0.31	0.63		0.51
SM_4	Similarity of distributors		-0.67[b]	0.37		0.61
SM_5	Similarity of personal selling			0.84		0.71
SM_6	Similarity of advertising		-0.16	0.77		0.63
SM_7	Similarity of competitors			0.66		0.44
SM_8	Similarity of product technology	-0.24		0.48	0.20	0.35
	BUYER RISK					
BR_1	Extent of after-sales service	0.32			0.47	0.35
BR_2	Purchase importance to buyers				0.53	0.30
BR_3	Technical complexity to buyers	0.27		-0.35	0.61	0.57
BR_4	Potential effect on buyer profit	0.51		0.18	0.35	0.42
BR_5	Familiarity of purchase task to buyers	0.55		-0.39	0.19	0.50
BR_6	Relative purchase size to buyers	0.27			-0.62	0.47
BR_7	Extent of buyer adaptation	0.58		-0.19	0.20	0.41
	COMPETITIVE ADVANTAGE					
CA_1	Extent of patent protection	0.63				0.41
CA_2	Product uniqueness	0.74		-0.22		0.62
CA_3	Competitive product newness	0.73				0.57
CA_4	Ease of competitive duplication	-0.53		0.25	-0.19	0.38
	DISTRIBUTION EASE					
DE_1	Buyer industry diversity	0.27			-0.41	0.25
DE_2	Importance of distributor support		0.93			0.86
DE_3	Expected extent of distributor support		0.68		-0.16	0.50
DE_4	Extent of distributor influence on buyers		0.91			0.82

[1] Four factors were forced in the analysis, these are denoted factors F_1, F_2, F_3, and F_4.

[2] The rectangular boxes indicate the highest significant factor loading on a particular variable.

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TABLE 6.7

GROUPS OF VARIABLES WITH MAXIMUM FACTOR LOADINGS[1]

F_1	F_2	F_3	F_4
$F_{1.1}$ Extent of patent protection	$F_{2.1}$ Similarity of distributors	$F_{3.1}$ Similarity of product characteristics	$F_{4.1}$ Extent of after-sales service
$F_{1.2}$ Product uniqueness	$F_{2.2}$ Importance of distributor support	$F_{3.2}$ Similarity of after-sales service	$F_{4.2}$ Buyer industry diversity
$F_{1.3}$ Competitive product newness	$F_{2.3}$ Expected extent of distributor support	$F_{3.3}$ Similarity of potential buyers	$F_{4.3}$ Purchase importance to buyers
$F_{1.4}$ Potential effect on buyer profit	$F_{2.4}$ Extent of distributor influence on buyers	$F_{3.4}$ Similarity of personal selling	$F_{4.4}$ Technical complexity to buyers
$F_{1.5}$ Familiarity of purchase task to buyers		$F_{3.5}$ Similarity of advertising	$F_{4.5}$ Relative purchase size to buyers
$F_{1.6}$ Extent of buyer adaptation		$F_{3.6}$ Similarity of competitors	
$F_{1.7}$ Ease of competitive duplication		$F_{3.7}$ Similarity of product technology	

[1]This table is derived directly from Table 6.6.

TABLE 6.8

RESULTS OF FACTOR ANALYSIS: PRINCIPAL COMPONENTS SOLUTION

Variable Name		VARIMAX ROTATED FACTOR MATRIX FACTORS[1]							
MARKETING TASK SIMILARITY		F_1	F_2	F_3	F_4	F_5	F_6	F_7	Communalities
SM_1	Similarity of product characteristics	-0.25		0.47[2]		0.37	-0.32		0.55
SM_2	Similarity of after-sales service	-0.19		0.75					0.64
SM_3	Similarity of potential buyers		-0.22	0.71	-0.20				0.64
SM_4	Similarity of distributors	-0.18	-0.63	0.44					0.67
SM_5	Similarity of personal selling			0.83				-0.20	0.75
SM_6	Similarity of advertising			0.79					0.66
SM_7	Similarity of competitors			0.63					0.45
SM_8	Similarity of product technology	-0.19		0.40		0.29	-0.28	0.27	0.46
BUYER RISK									
BR_1	Extent of after-sales service	0.25		-0.22	0.64				0.54
BR_2	Purchase importance to buyers				0.66		0.28		0.58
BR_3	Technical complexity to buyers			-0.24	0.26		0.66	0.32	0.67
BR_4	Potential effect on buyer profit	0.41			0.56			0.25	0.56
BR_5	Familiarity of purchase task to buyers	0.45		-0.39				0.55	0.68
BR_6	Relative purchase size to buyers				0.46		0.23	0.61	0.66
BR_7	Extent of buyer adaptation	0.51					0.21	0.55	0.65
COMPETITIVE ADVANTAGE									
CA_1	Extent of patent protection	-0.64			-0.18				0.46
CA_2	Product uniqueness	0.67		-0.16			0.37		0.65
CA_3	Competitive product newness	0.80							0.67
CA_4	Ease of competitive duplication	-0.48					-0.53		0.58
DISTRIBUTION EASE									
DE_1	Buyer industry diversity					-0.69			0.54
DE_2	Importance of distributor support		0.94						0.89
DE_3	Expected extent of distributor support		0.72		-0.28				0.62
DE_4	Extent of distributor influence on buyers		0.91						0.84

[1] Factors were selected on the basis of eigen values $\geq$ 1.0. Seven factors emerged, designated F_1 to F_7.

[2] Factor loadings shown in the rectangular boxes represent the highest factor loading for a particular variable.

TABLE 6.9

GROUPS OF VARIABLES WITH MAXIMUM FACTOR LOADING

F_1	F_2	F_3	F_4	F_5	F_6	F_7
$F_{1.1}$ Extent of patent protection	$F_{2.1}$ Similarity of distributors	$F_{3.1}$ Similarity of product characteristics	$F_{4.1}$ Extent of after-sales service	$F_{5.1}$ Buyer industry diversity	$F_{6.1}$ Technical complexity to the buyer	$F_{7.1}$ Familiarity of purchase task to buyer
$F_{1.2}$ Product uniqueness	$F_{2.2}$ Importance of distributor support	$F_{3.2}$ Similarity of after-sales service	$F_{4.2}$ Purchase importance to the buyer		$F_{6.2}$ Ease of competitive duplication	$F_{7.2}$ Relative purchase size to buyers
$F_{1.3}$ Competitive product newness	$F_{2.3}$ Expected extent of distributor support	$F_{3.3}$ Similarity of potential buyers	$F_{4.3}$ Potential effect on buyer profit			$F_{7.3}$ Extent of buyer adaptation
	$F_{2.4}$ Extent of distributor influence on buyer	$F_{3.4}$ Similarity of personal selling				
		$F_{3.5}$ Similarity of advertising				
		$F_{3.6}$ Similarity of competitors				
		$F_{3.7}$ Similarity of product technology				

[1] This table is derived directly from Table 6.8.

Seven factors emerged in this analysis. The mixed factor from the previous analysis split into other factors. Factor F_1 emerged as a competitive advantage factor, with the highest loading on three of the four variables describing competitive advantage. The fourth competitive advantage variable, ease of competitive duplication, had the highest factor loading on Factor F_6, but the loading on factor F_1 was not significantly lower.

Factor F_2 emerged as a distribution factor. All the marketing task similarity and complexity variables related to distribution had maximum loadings on this factor.

Factor F_3 emerged similar to the second factor in the previous analysis as a marketing task similarity factor. Of the eight variables describing marketing task similarity, seven had highest significant loadings on this factor.

Factors F_4 and F_6 emerged as buyer risk factors. Each appeared to relate to a different dimension of buyer risk. Factor F_4 seemed to relate to financial risk to the buyer. Factor F_6 did not emerge as cleanly as factor F_4 but all the variables with maximum loading on this factor were those defining buyer risk. The variable of buyer industry diversity appeared to represent a separate factor.

The results of the factor analyses provide some support for the internal consistency of the constructs postulated in the descriptive model. In the new product situations studied, the four constructs hypothesized represent dimensions of the situation that are consistently related in the situations examined.

6.4 TESTING THE DESCRIPTIVE HYPOTHESES

This section reports the tests of the two descriptive hypothesis sets

through the testing of the descriptive model.

6.4.1 Hypothesis Set H_1

The first hypothesis set of the research was stated as follows:

> The level of sales forecast error made by managers when screening a new product will be related to a set of variables which describe the marketing task similarity of the new product situation facing the managers compared to the existing products of the firm.

6.4.1.1 Results of Analyses

Four sets of analyses were used to test the first hypothesis set. The first two analyses were based on discriminant analyses of the additive model; the purpose of these analyses were to test both the significance of individual predictor variables in the hypothesis set and the significance of the entire set of variables.

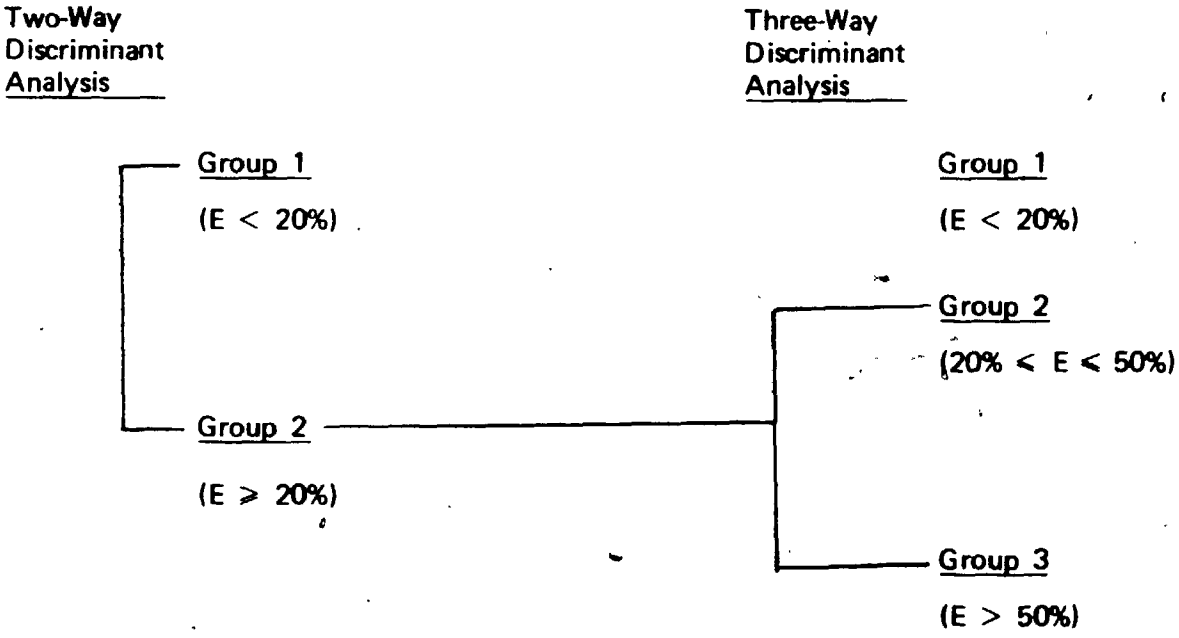
The second two analyses were based on discriminant analysis of the multiplicative model; the purpose of these analyses were to test the significance of the construct of marketing task similarity as defined by the set of marketing task similarity variables.

For all the two-way discriminant analyses two groups of new product situations were defined, those in which the sales forecast error was less than 20 percent ($E < 20$), and those in which the error was greater than or equal to 20 percent ($E \geq 20$).

For all the three-way discriminant analyses, three groups of new product situations were defined. The first group was the same as that for the two-way analysis; those situations in which sales forecast error was less than 20 percent ($E < 20$). The second and third groups were formed by subdividing the second group

from the two-way analysis into two groups, those in which sales forecast error was in the range greater than or equal to 20 percent but less than or equal to 50 percent ($20 \leq E \leq 50$) and those in which the error was greater than 50 percent ($E > 50$).

The basis for selection of the groups for the two-way and three-way discriminant analyses can be shown schematically as follows;



By subdividing the second group for a three-way analysis, two sets of variables can be identified; those which discriminate well between the two groups in the two-way analysis, and those that discriminate within the second group (Group 2) in the two-way analysis. Given the fact that the groups for three-way analysis are derived directly from the groups for two-way analysis, significant discriminating variables can be derived from both groups.

The first test was based on two way discriminant analysis for the additive model. With all eight marketing task similarity variables included, three variables were significantly related to sales forecast error ($\alpha < .001$), all in the directions hypothesized. The overall discrimination provided by this set of variables was

highly significant (F ratio on overall discrimination, $\alpha<.001$). With a reduced set of the most significant predictors, four variables were significantly related to sales forecast error, all in the direction hypothesized. The overall discrimination provided by this reduced set of variables was also high significant ($\alpha<.001$),

The second test was based on three-way discriminant analysis for the additive model. With all eight predictor variables included, four variables were significant ($\alpha<0.10$) all in the direction hypothesized. The overall discrimination was highly significant (F ratio, $\alpha<0.01$). With a reduced set of the most significant predictors, five variables were significantly related to sales forecast error ($\alpha<0.10$), all in the direction hypothesized.

Combining the results of the two-way and three-way discriminant analyses for the additive model, six of the eight predictor variables describing marketing task similarity were supported in their relationship with sales forecast error, all in the directions hypothesized.[3]

The analyses using the multiplicative model provided a test of the relationship of the construct of marketing task similarity to sales forecast error. The third test was based on two-way discriminant analysis for the multiplicative model. The index of marketing task similarity[4] was significantly related to sales forecast error ($\alpha<0.001$), in the direction hypothesized.

The fourth test was based on three-way discriminant analysis of the multiplicative model. The index of marketing task similarity was significantly related to sales forecast error ($\alpha<0.001$), in the direction hypothesized.

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[3]The results may be combined since two of the groups in the three-way discriminant analysis were formed by subdividing one group from the two-way analysis.

[4]For the multiplicative model, the index of marketing task similarity ISM was calculated as follows; $ISM = (SM_1 \cdot SM_2 \cdot \ldots \cdot SM_8)^{1/8}$. The discriminant analysis was then carried out based on this multiplicative index.

The results of the series of tests of the first hypothesis set are summarized in Table 6.10. Detailed analytic results for each of the individual analyses are tabulated in Appendix D.

6.4.1.2 Discussion of Results

The findings of the discriminant analyses indicated that six of the eight variables which describe marketing task similarity are significantly related to sales forecast error. The two-way discrimination provided greater overall significance than three-way discrimination; the set of most significant variables from this analysis constitute the most significant individual variables. Similarity of distributors, similarity of product technology, similarity of product characteristics, and similarity of after-sales service were the four most important and significant variables related to sales forecast error. None of these variables were intercorrelated at the critical level ($r>0.50$). Although similarity of potential buyers, similarity of personal selling, similarity of advertising, and similarity of competitors were not significantly related to sales forecast error in a two-way discrimination, the first three mentioned were all highly intercorrelated ($r>0.50$) with at least one of the significant variables which means that the effect of each on sales forecast error is included in their relationship with other variables describing marketing task similarity.

The three-way discriminant analysis revealed two more marketing task similarity variables significantly related to sales forecast error, similarity of personal selling and similarity of advertising. The fact that these variables emerged significantly in the three-way discriminant analysis, but not the two-way analysis means that they are significantly related to differences between new product situations where managers made medium errors ($20\%<E<50\%$) and high errors ($E>50\%$), but not between situations where managers made low errors ($E<20\%$) and medium plus high errors ($E\geq 20\%$).

TABLE 6.10

RESULTS OF THE TESTS OF HYPOTHESIS SET H_1

The level of sales forecast error in a new product introduction is related to:							
Hypothesis Number	Variable Symbol	Variable Name	Hypothesized Effect	Results of test of hypotheses			
				Test 1[1]	Test 2[2]	Test 3[3]	Test 4[4]
$H_{1.1}$	SM_1	Similarity of product characteristics	Negative	SUPPORTED	SUPPORTED	SUPPORTED	SUPPORTED
$H_{1.2}$	SM_2	Similarity of after-sale service	Negative	SUPPORTED	not supported		
$H_{1.3}$	SM_3	Similarity of potential buyers	Negative	not supported	not supported		
$H_{1.4}$	SM_4	Similarity of distributors	Negative	SUPPORTED	SUPPORTED		
$H_{1.5}$	SM_5	Similarity of personal selling	Negative	not supported	SUPPORTED		
$H_{1.6}$	SM_6	Similarity of advertising	Negative	not supported	SUPPORTED		
$H_{1.7}$	SM_7	Similarity of competitors	Negative	not supported	not supported		
$H_{1.8}$	SM_8	Similarity of product technology	Negative	SUPPORTED	SUPPORTED		

[1] Based on two-way discriminant analysis, additive model.

[2] Based on three-way discriminant analysis, additive model.

[3] Based on two-way discriminant analysis, multiplicative model.

[4] Based on three-way discriminant analysis, multiplicative model.

Two variables, similarity of potential buyers and similarity of competitors did not emerge as significantly related to sales forecast error in a new product situation in their a two-way or three-way discrimination. It is possible that similarity to internal firm-related aspects in a new product situation is more highly related to managers errors than external-environment aspects related to buyers, competitors, and distributors.

The multiplicative discriminant analyses based on both two-way and three-way discrimination indicated that the index representing the construct of marketing task similarity was significantly related to sales forecast error in the direction hypothesized.

6.4.2 Hypothesis Set H_2

The second hypothesis set of the research was stated as follows;

> The level of sales forecast error made by managers when screening a new product will be related to a set of variables which describe the marketing task complexity of the new product situation facing the firm.

The same four sets of analysis used to test the first hypothesis set were utilized to test the second set. The first two analyses were based on discriminant analysis of the additive model in order to test both the significance of individual predictor variables in the hypothesis set and the significance of the entire set of variables.

The second two analyses were based on discriminant analysis of the multiplicative model in order to test the significance of the constructs of buyer risk, competitive advantage, and distribution ease.

6.4.2.1 Results of Analyses

The first test was based on two-way discriminant analysis for the additive model. With all 15 marketing task complexity variables included, four variables were significantly related to sales forecast error ($\alpha<0.10$), all in the direction hypothesized. The overall discrimination provided by this set of variables was moderately significant (F ratio on overall discrimination, $\alpha<0.15$). With a reduced set of the most significant predictors, five variables were significantly related to sales forecast error, all in the direction hypothesized. The overall discrimination provided by the reduced set of predictors was significant ($\alpha<0.05$).

The second test was based on three-way discriminant analysis for the additive model. With all 15 predictors included in the analysis, only three variables were significantly related to sales forecast error, all in the direction hypothesized. The overall discrimination was significant ($\alpha<0.05$). With a reduced set of the most significant predictors, five variables were significant ($\alpha<0.10$). The significance of the overall discrimination was also increased ($\alpha<0.01$).

Combining the results of the two-way and three-way discriminant analyses for the additive model, eight of the 15 variables defining marketing task complexity were supported in their relationship with sales forecast error, all in the direction hypothesized.[5]

The third test of the entire group of variables describing marketing task complexity was based on two-way discriminant analysis of the multiplicative

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[5]The results may be combined since two of the groups in the three-way discriminant analysis were formed by subdividing one group from the two-way analysis.

model. Of the three indices describing marketing task complexity[6], only the index of distribution ease was related to sales forecast error with any level of significance, in the direction hypothesized ($\alpha<0.20$). The indices of buyer risk and competitive advantage were not significant.

The fourth test was based on three-way discriminant analysis of the multiplicative model. Again, only the index of distribution ease was significant ($\alpha<0.01$), and in the direction hypothesized. The indices of buyer risk and competitive advantage were not significant.

The results of the series of tests of the second hypothesis set are summarized in Table 6.11. Detailed analytic results for each of the individual analyses are tabulated in Appendix D.

6.4.2.2 Discussion of Results

The findings of the discriminant analyses indicated that eight of the 15 variables defining marketing task complexity are significantly related to sales forecast error. In the case of the discriminant analyses, both the two-way and three-way discrimination provided approximately equal overall significance of discrimination.

The most important and significant marketing task complexity variables in the two-way discriminant analysis were three variables describing buyer risk; extent of after-sale service, relative purchase size to the buyer, and extent of buyer adaptation, one variable describing competitive advantage; product uniqueness, and one

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[6]For the multiplicative model, the indices were calculated as follows;
Index of buyer risk = $IBR = (BR_1 \cdot BR_2 \cdot \ldots \cdot BR_7)^{1/7}$
Index of competitive advantage = $ICA = (CA_1 \cdot CA_2 \cdot \ldots \cdot CA_4)^{1/4}$
Index of distribution ease = $IDE = (DE_1 \cdot DE_2 \cdot \ldots \cdot DE_4)^{1/4}$

TABLE 6.11

RESULTS OF THE TESTS OF HYPOTHESIS SET H_2

The level of sales forecast error in a new product introduction is related to:							
Hypothesis Number	Variable Symbol	Variable Name	Hypothesized Effect	Results of tests of hypotheses[1]			
				Test 1[1]	Test 2[2]	Test 3[3]	Test 4[4]
		BUYER RISK					
$H_{2.1}$	BR_1	Extent of after-sales service	Positive	SUPPORTED	not supported	not supported	not supported
$H_{2.2}$	BR_2	Purchase importance to buyers	Positive	not supported	not supported		
$H_{2.3}$	BR_3	Technical complexity to buyers	Positive	not supported	SUPPORTED		
$H_{2.4}$	BR_4	Potential effect on buyer profit	Positive	not supported	not supported		
$H_{2.5}$	BR_5	Familiarity of purchase task to buyers	Negative	not supported	not supported		
$H_{2.6}$	BR_6	Relative purchase size to buyers	Positive	SUPPORTED	not supported		
$H_{2.7}$	BR_7	Extent of buyer adaptation	Positive	SUPPORTED	not supported		
		COMPETITIVE ADVANTAGE					
$H_{2.8}$	CA_1	Extent of patent protection	Negative	not supported	not supported	not supported	not supported
$H_{2.9}$	CA_2	Product uniqueness	Positive	SUPPORTED	SUPPORTED		
$H_{2.10}$	CA_3	Competitive product newness	Positive	not supported	SUPPORTED		
$H_{2.11}$	CA_4	Ease of competitive duplication	Positive	not supported	not supported		
		DISTRIBUTION EASE					
$H_{2.12}$	DE_2	Importance of distributor support	Positive	not supported	not supported	SUPPORTED	SUPPORTED
$H_{2.13}$	DE_3	Expected extent of distributor support	Negative	not supported	not supported		
$H_{2.14}$	DE_4	Extent of distributor influence on buyers	Positive	not supported	SUPPORTED		
$H_{2.15}$	DE_1	Buyer industry diversity	Positive	SUPPORTED	SUPPORTED		

[1] Based on two-way discriminant analysis, additive model.

[2] Based on three-way discriminant analysis, additive model.

[3] Based on two-way discriminant analysis, multiplicative model.

[4] Based on three-way discriminant analysis, multiplicative model.

variable describing distribution ease; buyer industry diversity. Of these five variables, none were correlated at the critical level ($r>0.50$). Of the ten variables not significant in the two-way discrimination, only two were highly correlated with one or more of the set of most significant predictors.

The three-way discriminant analysis revealed three more significant marketing task complexity variables, one more variable describing buyer risk; technical complexity to the buyer, one more variable describing competitive advantage; competitive product newness, and one more variable describing distribution ease; extent of distributor influence on buyers.

Buyer risk emerged as the most important and significant of the constructs in the hypothesized model in its relationship to sales forecast error. Of the seven variables describing buyer risk, four emerged in the set of most important and significant predictors, or 57 percent. Competitive advantage and distribution ease emerged as the next most important, with each construct having two of the four variables describing it included in the set of most important and significant predictors.

The multiplicative discriminant analyses based on both two-way and three-way discrimination indicated that the index representing the construct of distribution ease was significantly related to sales forecast error in the direction hypothesized, but that the indices describing buyer risk and competitive advantage were not.

6.5 TESTING PREDICTIVE HYPOTHESIS H_3

The third hypothesis of the research was stated as follows;

> The discriminant model based on the set of variables describing marketing task similarity and complexity can significantly predict probabilities of different levels of sales forecast error in new product situations.

6.5.1 Results of Analyses

Using the simulated random sample approach for bias correction,[7] the predictive ability of the model was statistically significant for two-way discriminant analyses based on the additive model. Analyses based on the most significant set of marketing task similarity variables, marketing task complexity variables, and combined variables were all significant in their predictive power after correction for bias. The predictive power of the additive model in three-way discrimination was not significant, except for that based on a reduced set of the most significant set of predictors.

The predictive power of the multiplicative model was not significant, either in two-way or three-way discrimination.

Using the split sample approach for bias correction, the predictive ability of the model was relatively low (60 percent correctly classified) but statistically significant ($\alpha<0.01$). The model utilized for the split sample test was the

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[7]The percent correctly classified criterion for a sample of random data is shown for each test of the predictive model in Table 6.12.

two-way discriminant model based on the most significant set of predictors. The associated discriminant function for this predictive model is as follows;

$$Z = -36.5 + 1.64SM_1 + 2.80SM_2 + 3.72SM_4 + 1.71SM_8 + 2.88BR_1 + 2.98CA_2 + 1.82DE_1 + 1.69BR_6 + 1.42BR_7 \quad (6-1)$$

where;

SM_1 = Similarity of Product Characteristics

SM_2 = Similarity of After-Sale Service

SM_4 = Similarity of Distributors

SM_8 = Similarity of Product Technology

BR_1 = Extent of After-Sale Service

BR_6 = Relative Purchase Size to Buyers

BR_7 = Extent of Buyer Adaptation

CA_2 = Product Uniqueness

DE_1 = Buyer Industry Diversity

The probabilities of that particular new product situation having each error level can then be calculated from the discriminant functions as outlined in Appendix C. By using these equations for a particular new product situation, managers can evaluate the probabilities and approximate the probability distribution for sales volume of a particular new product.

The results of the tests of the third hypothesis are summarized in Table 6.12.

TABLE 6.12

SUMMARY OF TESTS OF HYPOTHESIS H_3

TEST USING SIMULATED RANDOM SAMPLE APPROACH FOR BIAS CORRECTION

Model	Percent correctly classified	Percent correctly classified random data	Value of t
Additive model, two-way discrimination on the reduced set of most significant marketing task similarity variables	70%	55%	4.05[a]
Additive model, two-way discrimination on the reduced set of most significant marketing task complexity variables	62%	55%	1.89[b]
Additive model, two-way discrimination on the reduced set of most significant marketing task similarity and complexity variables	73%	57%	4.86[a]
Additive model, three-way discrimination on the reduced set of most significant marketing task similarity and complexity variables	61%	57%	1.11

TEST USING SPLIT SAMPLE APPROACH FOR BIAS CORRECTION

Model	Percent correctly classified	Value of t
Additive model, two-way discrimination based on the reduced set of most significant predictors	60%	2.73[a]

[a]Significant at $\geq .01$ level.

[b]Significant at $\geq .05$ level.

[c]Significant at $\geq .10$ level.

6.6 TESTING THE ANALYTICAL ASSUMPTIONS

The assumption of equal covariation and dispersion of the predictor variables for each of the discriminant groups was tested by examining the equality of the covariance matrices for each of the groups in each discriminant analysis. The assumption was approximately met in all cases.

Multinormality of the predictor variable scales was tested by examination of the percent of cases between plus or minus one standard deviation of the mean for each variable scale. Of the 23 predictor variables, 14 were quite close to univariate normal by this test (±10% of cases within ± one standard deviation) and another 6 were reasonably close (±15% of cases within ± one standard deviation. The remaining 3 variable scales were significantly non-normal.

The assumption of equal probabilities of a sample point's (new product situation) membership in each defined discriminant group was adhered to by keeping the group sizes as close as possible to each other. In the case of the two-way analyses, the sizes of the two groups were 81 and 104, with the larger group constituting 56% of the sample, as compared to 50% for equal group sizes. In the case of the three-way analyses, the sizes of the three groups were 67, 77 and 41, with the larger group constituting 41% of the sample, as compared to 33.3% for equal group sizes.

Equal costs of misclassification of a sample point on new product situations were assumed for this application of discriminant analysis. The significance of this assumption is somewhat obscured because the output of the predictive model is intended to be only one input into the screening decision process.

6.7 SUMMARY OF FINDINGS

The empirical results revealed that six of the hypotheses in the first

set were reasonably supported, and that eight of the hypotheses in the second set were reasonably supported. Support for both these sets of hypotheses came from descriptive discriminant analysis based on both an additive and multiplicative model.

The two-way additive discriminant model provided a higher level of discrimination than the multiplicative model, and was therefore used for testing the predictive hypothesis. This predictive hypothesis was reasonably, but not strongly supported.

Analysis of the associations between predictor variables using factor analysis revealed good internal consistency of the four major intervening constructs of the descriptive model; marketing task similarity, buyer risk, competitive advantage, and distribution ease.

CHAPTER VII

SUMMARY AND IMPLICATIONS

7.1 INTRODUCTION

This final chapter consists of three main sections. The first presents a summary of the research. The second section reports the implications of the research findings for management and for public policy. The third section reports implications for the theoretical area of management decision models. The final section suggests related topics for further research.

7.2 RESEARCH SUMMARY

This research concerns the errors made by managers in forecasting sales when screening new product ideas for potential development and marketing, and therefore concerns the uncertainty of these sales forecasts. The main objectives of the study were to determine the levels of sales forecast error made by managers, to identify some factors which were associated with the error, and to test the predictive utility of a descriptive model based on the factors to assist managers in evaluating sales forecast uncertainty when screening new product ideas.

A hypothesized descriptive model was formulated, which hypothesized that the level of sales forecast error made by managers when screening a new product is related to variables which describe the similarity and complexity of the marketing tasks facing them in the situation. The empirical tests of the model were based on data obtained by investigating 185 new products developed by Canadian industrial goods firms.

The hypothesized descriptive model developed for the study was supported in part by the empirical findings. The results suggest that the ability of managers to accurately forecast sales for new products at the screening stage is influenced by factors that describe the marketing tasks facing the managers in the situation.

The most important variables describing the marketing tasks that are related to sales forecast error were identified. Fourteen hypothesized predictor variables – Similarity of Product Characteristics, Similarity of After-Sales Service, Similarity of Distributors, Similarity of Personal Selling, Similarity of Advertising, Similarity of Product Technology, Extent of After-Sales Service, Technical Complexity to Buyers, Relative Purchase Size to Buyers, Extent of Buyer Adaptation, Product Uniqueness, Competitive Product Newness, Extent of Distributor Influence on Buyers, and Buyer Industry Diversity – appeared to influence the level of sales forecast error made by managers, all in the hypothesized directions. These variables define the constructs of the proposed model – marketing task similarity, and marketing task complexity, as defined by the constructs of buyer risk, competitive advantage, and distribution ease. Evidence of the validity of these constructs was reasonably provided by factor analysis.

Of the four constructs, marketing task similarity was the most important in terms of both the discriminatory power of the variables defining the construct and the proportion of hypothesized variables supported in their relationship to sales forecast error. Of the eight variables defining marketing task similarity, six were supported or 75 percent. Variables defining buyer risk were the second most important, with four of the seven hypothesized variables supported in their relation to sales forecast error, or 57 percent. Variables defining competitive advantage and distribution ease were lowest in importance, with each having two out of four of the

hypothesized variables supported, or 50 percent. The importance of marketing task similarity is magnified by the evidence from correlation analysis that showed that new product situations with high marketing task similarity tended to be similar for many of the variables defining similarity of the marketing tasks.

The research findings may also be viewed in terms of the marketing tasks that emerge as most highly related to sales forecast error made by managers. The relative importance of the tasks as described by the predictor variables could not be completely derived from the findings because many of the variables relate to more than one marketing task. However, variables most strongly related to the product performance task, the personal selling task, and the distribution task emerged most prominently. This suggests that the similarity and complexity of the decisions faced by managers in these tasks are most highly related to managers difficulty in accurately forecasting sales, and should therefore be evaluated most carefully when screening new product ideas.

The predictive power of the model was statistically significant but moderate in magnitude, however the first step toward a powerful predictive model is a complete and significant descriptive model. This research has provided validation for a set of constructs that can serve as the basis for a more comprehensive and exhaustive model.

7.3 IMPLICATIONS OF THE FINDINGS

In this section, the major implications of this research to both business managers and public policy formulators are outlined. These implications, while based on the empirical findings, are somewhat speculative, and were also influenced by informal discussions with managers during the data collection phase of the research. In addition, some implications of the research to the area of normative

marketing decision models are outlined.

7.3.1 Implications for the Management of Technological Innovation

The evidence of the research showed that in the majority of new product development situations, managers made relatively high errors in their forecasts of sales, and that negative errors were far more dominant than positive errors. Given that management decisions are frequently made at the screening stage to commit considerable resources to development and marketing of new products, this research points to the need for managers to improve their evaluation of the uncertainty of their sales forecasts. The model developed and tested in this research has identified a set of characteristics of the marketing tasks faced by managers that influence the accuracy of their sales forecasts. When evaluating the uncertainty of their sales forecasts, managers should consider the nature of the future marketing tasks which must be accomplished in order to successfully market the product in terms of the similarity of these tasks. Managers should also consider the complexity of the tasks that may be introduced by greater risk to the buyer, lower competitive advantage, and lower ease of distribution for the product.

Recent work in normative management decision models has suggested the desirability of managers structuring qualitative inputs that are relevant to their decisions so that at the least the most important qualitative factors are accounted for, and at the most are explicitly taken into the decision process. One aim of this research focused on the testing of the utility of the descriptive model as a predictive guide for managers in evaluating the uncertainty of their sales forecasts. The analytic form of the model has illustrated a method managers could use to explicitly relate qualitative variables that influence the accuracy of their sales forecasts to a quantitative probability distribution reflecting sales forecast uncertainty. The scales

developed for the study provide a basis for structuring important qualitative characteristics of new product situations. If a manager can characterize his own new product situation on each of the dimensions outlined in the predictive model, by using the equations and procedure outlined in Appendix C he can generate a probability distribution for his sales forecast which reflects the probability of error in that forecast. Because the model has been derived from 185 diverse new product situations, it represents the experience of many new product situations, and provides the manager with the basis for comparison with his subjective evaluation of forecast uncertainty.

7.3.2 Implications for Public Policy

Successful technological innovations are a vital concern to public policy formulators, particularly in the area of assistance for innovation. The success of managers in new product ventures can affect the welfare and stability of the economy, influence future expenditures on new product development, and determine the future of government programs for science and technology. The implications of this research to managers in business are also relevant to government policy formulators.

Recent government activity in innovation assistance has increased tremendously, both in the total amount and variety of assistance available. It is in the interest of administrators of these programs to fund successful new product projects and to recognize situations where sales forecasts made by managers may be subject to high uncertainty.

In most cases, administrators of programs for innovation assistance are approached early in the development process, around the screening stage, since firms generally wish to reduce the financial risk of developing a new product as soon

as possible. At this stage, information about the characteristics of the new product situation available to administrators is usually scarce.

In cases where a new product situation is considered for assistance, administrators should consider sales forecasts with low marketing task similarity carefully to determine how the managers of the firm have arrived at their forecasts and how they plan to deal with the unfamiliar set of marketing tasks to be accomplished. In cases where higher marketing task complexity is indicated by higher risk to the buyer, lower competitive advantage, and lower distribution ease, the same set of questions should be addressed. The predictive model developed could be utilized by administrators in the same way as managers in a particular new product situation.

7.3.3 Implications for Marketing Theory

The findings of this research have implications for marketing theory in the area of normative decision models. The problem of introducing qualitative considerations into the normative decision process has been raised. This research has proposed and tested a use of the discriminant analytic method to provide a qualitative input in a way which is consistent with an accepted method of treating uncertainty in terms of a probability distribution. This use of discriminant analysis has potential applications for the characterizing of situational dimensions related to uncertainty in other stages of the new product development process, involving outcomes other than sales volume such as development costs. There are also potential applications in the characterizing of the uncertainty dimension in other areas of marketing, for example consumer purchase behavior.

7.4 AREAS FOR FUTURE RESEARCH

The present research represents an advance in the formulation of decision models for screening new product ideas, the linking of a set of qualitative decision variables to an important quantitative input to the screening decision, an estimate of the uncertainty attached to manager's forecasts of sales. The results of the research indicate that this attempt has not been completely successful, but this is consistent with expectations. However, this type of linkage has potential for inclusion in a quantitative management decision model for screening.

The following points outline suggestions for future research, and concern refinements to the present study and the addressing of new questions raised by the research.

7.4.1 Refinements to the Study

Further research could attempt to develop more complete sets of variables to reflect the wide range of dimensionality related to each of the model constructs. Since this would tend to increase the number of total variables in the model with restricted sample sizes available in such empirical studies, development of new combinatorial methods for the variables represents another refinement. These methods would likely involve more complex indices of sets of variables representing different relationships to the constructs.

A second refinement would concern exploration of the measurement of the constructs of the hypothesized model for the present research in terms of the dimensions individual managers connect with the constructs. The way in which managers see the constructs, for example distribution ease, was never determined. Determining these dimensions might help to increase the predictive utility of the model.

7.4.2 New Research

A useful descriptive study resulting from the present study would be the investigation of how managers actually take forecast uncertainty into account in making the screening decision for a number of new product proposals. The purpose of this research would be to improve the integration of a qualitative decision input model into the real-world screening decision process. A second descriptive study could explore differences in perception of different managers within individual firms of the various situational dimensions related to forecast uncertainty. The purpose of this research would be to determine the sensitivity of a qualitative input model to the type of particular manager or managers making the subjective judgements.

The underlying objective of the research was to contribute to the improvement of the new product development process by focussing on the problem of sales forecast uncertainty. To the extent the research provided an insight into the importance of the problem, created an awareness of the need for better methods of uncertainty evaluation, and revealed new areas for research, this objective was met.

APPENDIX A

LIST OF VARIABLES AND OPERATIONAL DEFINITIONS

Empirical data for the study, which existed in the form of a data bank, were obtained during a personal interview with managers supplemented with a mailed questionnaire.[1] The main variable of the study, sales forecast error in a new product introduction, is defined as the percentage difference between the actual unit sales for the new product in the first year of introduction to the market and the estimate of unit sales made by managers at the screening decision stage of the new product development.[2]

A.1 MEASURES OBTAINED DURING THE PERSONAL INTERVIEW

During a two to four hour personal interview, which was based on a lengthy printed questionnaire, managers were asked to relate a case history of the development of two new products. Following this discussion, the following questionnaire items were obtained to compute sales forecast error. In order to measure the actual unit sales on market introduction, the following question was asked;

In this section we are interested in measuring the differences, if any, between your company's market performance estimates for the product when it was first proposed to the actual market performance of the product.

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[1] A description of the sample of firms is provided in Section 5.1.

[2] When possible, unit sales were obtained for the first five years of the new product introduction. This raised the problem of reducing errors in various years to some common basis for the discriminant analysis. Since errors in subsequent years correlated highly with errors in the first year, it was decided to use first year sales only in computing error.

What sales have been achieved each year to date?

Year	*Actual Units*
1	____
2	____
3	____
4	____
5	____

In order to measure the estimate of unit sales made at the screening decision stage, the following question was asked;

At the very beginning of the new product's development, the product's future prospects had probably been assessed at least in some general terms, even if there were few clear indicators of the future. We would like to know what managements beliefs were at that time about a number of factors, and how these beliefs compare to what actually occurred.[3]

Year	*Unit Sales*	*Change from Actual*[4]
1	____	____
2	____	____
3	____	____
4	____	____
5	____	____

The sales forecast error was then computed as;

$$E = \left| \frac{\text{Actual unit sales - Estimated unit sales}}{\text{Estimated unit sales}} \right| \times 100$$

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[3] It is important to note that at this point in the interview, efforts were made to obtain written documentation for these estimates. However, in the case of several smaller firms, this documentation was not available. In those cases the managers best estimates were obtained.

[4] This measure was expressed as $(\frac{\text{actual}}{\text{estimated}})$ on the questionnaire, then converted to the measure used in this study.

A.2 MEASURES OBTAINED WITH THE MAILED QUESTIONNAIRE

The mailed questionnaire which was accompanied by an explanatory letter, began with the following preamble:

PRODUCT: _____

We would like you to provide a description of the product situation on a number of characteristics, AS YOU WOULD HAVE DESCRIBED IT JUST PRIOR TO THE FIRST STAGE OF DEVELOPMENT. That is, we would like you to imagine you are considering the product as a possible development project, back in time before any significant time or money had been spent on product development. At that time you would have known less about several aspects of the product than you know now, but you would have had at least some impression about all aspects of the product.

We recognize that there is some difficulty in trying to view the product from a point in the past but our research analysis will take that difficulty into account. So please just assume the "pre-development" view to the best extent possible.

You will notice that the statements each have several alternative phrases to allow different scales of description. The scales require your judgement and interpretation. Even if you are somewhat uncertain of the situation, choose from each scale the phrase that best indicates your impression. In some cases, a numerical estimate is required.

For each statement, check the phrase on the scale (or fill in the estimate) that you think was most appropriate for your "pre-development" point of view.

The following set of scales was then presented to the respondents to measure the set of 23 predictor variables. The name of each variable is shown above each scale, and the coding directions used shown to the right of each scale. These did not appear on the actual questionnaire items.

A.2.1 Similarity of product characteristics, SM_1

Compared to existing company products, this product will be	a slight modification of an existing company product	a moderate modification of an existing company product	a major modification of an existing company	for the most part a new product to the company	a completely new product to the company	Code: 1 to 5 right to left
	_____	_____	_____	_____	_____	

A.2.2 Similarity of after-sales service, SM_2

The type of after-sales service required for this product will be	identical to present products	very similar to present products	somewhat similar to present products	quite unlike present products	totally unlike present products	Code: 1 to 5 right to left
	_____	_____	_____	_____	_____	

A.2.3 Similarity of potential buyers, SM_3

The potential customers for this product will be	present customers only	mostly present customers	about equal present and new customers	mostly new customers	new customers only	Code 1 to 5, right to left.

A.2.4 Similarity of distributors, SM_4

This product will be distributed to potential customers	through present distributors	mostly through present distributors partly through new distributors	equally between new and present distributors	mostly through new distributors	entirely through new distributors	Code. 1 to 5, right to left.[5]

OR _____ We will sell direct _____

A.2.5 Similarity of personal selling, SM_5

For our salesmen or representatives the selling task for this product will be	identical to that for existing products	somewhat similar to that for existing products	moderately similar to that for existing products	very different from existing products	extremely different from existing products	Code: 1 to 5, right to left.

A.2.6 Similarity of advertising, SM_6

The company's existing advertising methods will be	completely suited to this product	fairly suited to this product	moderately suited to this product	quite unsuited to this product	very suited to this product	Code. 1 to 5, right to left.

A.2.7 Similarity of competitors, SM_7

Our competitors in this product market will be	all present competitors	mostly present competitors	about equal present and new competitors	mostly new competitors	all new competitors	Code. 1 to 5, right to left.

A.2.8 Similarity of product technology, SM_8

The technology on which this product will be based has been used in our previous products	very extensively	fairly extensively	to a moderate degree	to a small degree	not at all	Code 1 to 5, right to left.

A.2.9 Extent of patent protection, CA_1

This product or its components will be under	no patent coverage	minor patent coverage	moderate patent coverage	significant patent coverage	major patent coverage	Code 1 to 5. right to left.

[5] For this variable, selling direct was coded the same as selling "through present distributors".

A.2.10 Extent of after-sale service, BR_1

This product will require	no after-sales service	minor after-sales service	moderate after-sales service	quite a lot of after-sales service	very extensive after-sales service	Code: 1 to 5, right to left.

A.2.11 Product uniquness, CA_2

Compared to products of this type presently on the market, this product will have	no unique features	a few unique features	several unique features	many unique features	a great many unique features	Code: 1 to 5, right to left.

A.2.12 Buyer industry diversity, DE_1

The potential customers for this product will be	all in a single industry	mostly in a single industry	in a few different industries	in several different industries	in many different industries	Code. 1 to 5, right to left.

A.2.13 Purchase importance to the buyer, BR_2

For the potential customers, purchase of this product type will be	not essential to the customer's operation	somewhat essential to the customer's operation	quite essential to the customer's operation	very essential for the customer's operation	absolutely essential for the customer's operation	Code. 1 to 5, right to left.

A.2.14 Competitive product newness, CA_3

From the viewpoint of our company this product will be	virtually identical to competition products on the market	fairly similar to competition products on the market	moderately similar to competition products on the market	only slightly similar to competition products on the market	not at all similar to competition products on the market	Code: 1 to 5, right to left.

A.2.15 Technical complexity to the buyer, BR_3

To the potential customer, this product will likely be seen as	technically very simple	technically fairly simple	technically somewhat complex	technically fairly complex	technically very complex	Code: 1 to 5, right to left.

A.2.16 Potential product effect on buyer profits, BR_4

For potential customers the purchase of this product will likely have	no effect on their profitability	a pretty low effect on their profitability	a moderate effect on their profitability	a great effect on their profitability	a very great effect on their profitability	Code: 1 to 5, right to left.

A.2.17 Familiarity of purchase task to buyers, BR_5

In buying this product, the typical potential customer will face	a completely familiar buying task	a fairly familiar buying task	somewhat of a new buying task	a fairly new buying task	a completely new buying task	Code: 1 to 5, left to right.

A.2.18 Relative purchase size to buyers, BR_6

In relation to customers' average dollar size of purchase, purchase of this product will be	an insignificantly small purchase	a fairly small purchase	a moderate purchase	a large purchase	a very large purchase	Code: 1 to 5, left to right.

A.2.19 Extent of buyer adaptation, BR_7

In order to utilize this product, potential customers will need to make	no changes in their present process or product	minor changes in their present process or product	moderate changes in their present process or product	fairly major changes in their present process or product	very major changes in their present procress or product	Code: 1 to 5, left to right.

A.2.20 Importance of distributor support, DE_2

In selling this product, the active support of the distributors will be	of almost no importance	of low importance	of moderate importance	of high importance	of crucial importance	Code: 1 to 5, left to right[6]

A.2.21 Expected extent of distributor support, DE_3

In promoting and selling this product to their customers, the distributors will likely be willing to provide our product with	very extensive and strong support	fairly extensive and strong support	moderate support	only a little support	no noticeable support	Code: 1 to 5, left to right.[7]

A.2.22 Extent of distributor influence on buyers, DE_4

The power of the distributors in this market in influencing sales to customers will likely be	very low	low	moderate	high	very high	Code: 1 to 5, left to right.[8]

[6] For a product which was sold direct, this variable was coded "of almost no importance.

[7] For a product which was sold direct, this variable was coded, "very extensive and strong support".

[8] For a product which was sold direct, this variable was coded, "very low".

A.2.23 Ease of competitive duplication, CA_4

Our anticipated competitors in this product market could produce a technically equivalent product	with no difficulty	with only a little difficulty	quite a lot of difficulty	with great difficulty	with extreme difficulty	Code: 1 to 5, right to left.

APPENDIX B

STATISTICAL CHARACTERISTICS OF THE PREDICTOR VARIABLE SCALES AND DESCRIPTION OF FIRMS IN THE SAMPLE

B.1 INTRODUCTION

The purpose of this Appendix is to detail some important statistical characteristics of the ordinal likert scales used to measure the set of predictor variables.

TABLE B.1

CHARACTERISTICS OF THE MARKETING TASK SIMILARITY VARIABLES (N = 185)

Variable Measure		Low Value	High Value	Mean	Standard Deviation
SM_1	Similarity to existing products	1	5	2.65	1.17
SM_2	Similarity of after-sale service	1	5	3.59	1.09
SM_3	Similarity of potential buyers	1	5	2.94	1.05
SM_4	Similarity of distributors	1	5	4.19	1.31
SM_5	Similarity of personal selling	1	5	3.71	1.18
SM_6	Similarity of advertising	1	5	3.84	1.19
SM_7	Similarity of competitors	1	5	3.73	1.23
SM_8	Similarity of product technology	1	5	3.27	1.16

TABLE B.2

CHARACTERISTICS OF THE MARKETING TASK
COMPLEXITY VARIABLES (N = 185)

Variable Measure		Low Value	High Value	Mean	Standard Deviation
CA_1	Extent of patent protection	1	5	3.97	1.63
BR_1	Extent of after-sale service	1	5	2.62	1.10
CA_2	Product uniqueness	1	5	2.77	1.44
DE_1	Buyer industry diversity	1	5	2.48	1.67
BR_2	Purchase importance to the b buyer	1	5	2.74	1.50
CA_3	Competitive product newness	1	5	3.06	1.55
BR_3	Technical complexity to the buyer	1	5	2.62	1.20
BR_4	Potential product effect on buyer profit	1	5	2.72	0.77
BR_5	Familiarity of purchase task to buyer	1	5	2.23	1.31
BR_6	Relative purchase size to the buyer	1	4	2.69	0.80
BR_7	Extent of buyer adaptation	1	5	2.04	1.11
DE_2	Importance of distribution support	1	5	2.22	2.41
DE_3	Expected extent of distributor support	1	5	1.67	1.06
DE_4	Extent of distributor influence on buyers	1	5	2.02	1.84
CA_4	Ease of competitive duplication	1	5	3.62	0.86

TABLE B.3

FREQUENCY DISTRIBUTION OF THE PREDICTOR VARIABLES (N = 185)

Variable Name	Frequency Distribution: Number of Cases in Each Category					
	Categories (See Appendix A for category definitions)					
	1	2	3	4	5	Totals[1]
Similarity to existing products	38(21)	45(24)	57(31)	34(18)	11(6)	185(100%)
Similarity of after-sale service	9(5)	20(11)	48(26)	70(38)	37(20)	"
Similarity of potential buyers	17(9)	47(25)	60(32)	52(28)	9(5)	"
Similarity of distributors	14(8)	15(8)	16(9)	16(9)	124(67)	"
Similarity of personal selling	12(6)	21(11)	27(15)	74(40)	51(28)	"
Similarity of advertising	10(5)	20(11)	27(15)	60(32)	68(37)	"
Similarity of competitors	14(8)	22(11)	22(11)	68(37)	59(32)	"
Similarity of product technology	15(8)	33(17)	51(28)	59(32)	27(15)	"
Extent of patent protection	11(6)	21(11)	24(13)	36(20)	93(51)	"
Extent of after-sale service	23(12)	69(37)	60(32)	21(11)	12(7)	"
Product uniqueness	26(14)	59(32)	53(29)	25(14)	22(11)	"
Buyer industry diversity	49(26)	60(32)	34(18)	22(11)	29(11)	"
Purchase importance to the buyer	36(19)	43(23)	57(31)	31(17)	18(10)	"
Competitive product newness	18(10)	50(27)	52(28)	32(17)	33(18)	"
Technical complexity to buyer	25(14)	71(38)	53(29)	22(12)	14(8)	"
Product effect on buyer profits	14(8)	58(31)	81(44)	29(16)	3(2)	"
Familiarity of purchase task to the buyer	55(30)	74(40)	24(13)	23(12)	9(5)	"
Relative purchase size to the buyer	17(9)	59(31)	74(40)	34(19)	1(1)	"
Extent of buyer adaptation	72(39)	56(30)	38(21)	15(8)	4(2)	"
Importance of distributor support	107(58)	8(4)	13(7)	36(19)	21(11)	"
Expected extent of distributor support	119(64)	24(13)	29(16)	10(5)	3(2)	"
Extent of distributor influence on buyers	110(6)	9(4)	28(15)	28(15)	10(5)	"
Ease of competitive duplication	6(3)	12(6)	62(33)	75(41)	30(16)	"

[1] Percentages in each category are indicated in brackets. Percentages may not add exactly to 100% due to rounding.

TABLE B.4

DESCRIPTION OF FIRMS STUDIED BY INDUSTRY AND ANNUAL SALES

Industry	Number of Firms						
		Annual Sales ($ Millions)					
	No Resp.	2 or Less	>2 to 10	>10 to 40	>40 to 100	>100	Totals
Electrical Equipment, (small and large) Electrical Products; Scientific Instrumentation; Process Instrumentation	3	11	12	2	1	3	32
Chemicals, heavy; Specialty; Pharmaceutical; Protective and Coatings	1	3	8	3	1	6	22
Equipment, light, industrial, Components; Machine Tools and Supplies; Material Handling, Vehicles and Equipment; Airconditioning and other Building Equipment	1	5	10	8	2	0	26
Vehicles, components, fabricated metal parts Aircraft, Automotive, Agricultural	2	2	5	7	3	2	21
Miscellaneous, including Industrial Textiles; Plastic and Rubber Fabricated Parts, Construction Materials, Packaging Materials, Other Raw Materials	1	0	4	3	2	3	13
Totals	8	21	39	23	9	14	114

APPENDIX C

THE MATHEMATICAL BASIS FOR A DISCRIMINANT MODEL

C.1 INTRODUCTION

The use of multiple discriminant analysis has formed an important part of both the model-building and data-analysis for this research. The purpose of this appendix is twofold;

1. to outline the mathematical basis for multiple discriminant analysis as a descriptive analytical technique in the context of this research.
2. to outline the use of a multiple discriminant model as a predictive model and explain the potential use of the model output by managers in screening new products.

C.2 THE MATHEMATICAL BASIS FOR MULTIPLE DISCRIMINANT ANALYSIS[1]

The objective of a discriminant analysis applied to this research is to classify new product situations by a set of independent variables into one of two or more mutually exclusive and exhaustive categories of sales forecast error. The following notation can be used for this research model;

X_{ji} = the value of the j^{th} predictor variable for the i^{th} new product situation.

b_j = the discriminant coefficient for the j^{th} predictor variable.

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[1]This section is derived directly from D.G. Morrison, "On the Interpretation of Discriminant Analysis," *Journal of Marketing Research*, Vol. VI (May 1969), pp. 156-63.

Z_i = the discriminant score for the i^{th} new product situation.

Z_{cr} = the critical value for the discriminant score.

The discriminant score Z_i for each new product situation i is then a linear function of the set of predictor variables. That is,

$$Z_i = b_o + b_1X_{1i} + b_2X_{2i} \ldots\ldots b_n X_{ni} \qquad (C\text{-}1)$$

For purposes of explanation, the discriminant analysis for two groups will be discussed first. The expansion to n-group discriminant analysis will be discussed at the end of the appendix.

The classification procedure for new product situations then follows;

If $Z_i > Z_{cr}$ classify new product situation i as belonging to Group 1

If $Z_i < Z_{cr}$ classify new product situation i as belonging to Group 2.

The classification boundary will then be the locus of points where;

$$b_o + b_1X_{1i} + \ldots\ldots bnX_{ni} = Z_{cr} \qquad (c\text{-}2)$$

C.2.1 Discriminant groups: Relation to sales forecast uncertainty estimates and error

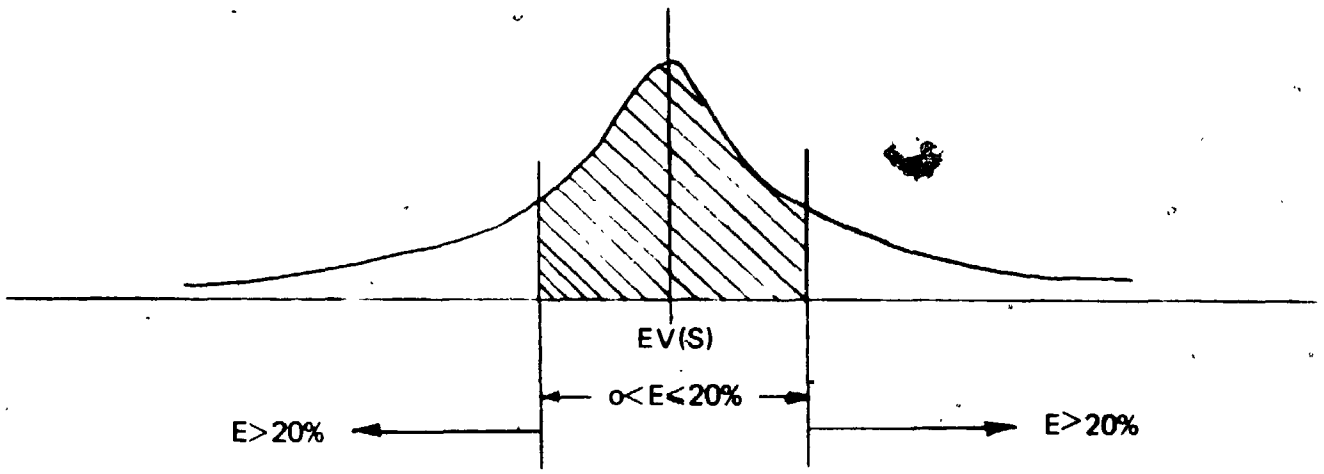
In this research, the dependent variable in the descriptive analysis is the level of sales forecast error. The discriminant groups are groups of new product situations within different ranges of sales forecast errors. For a two-group analysis, the groups were defined as follows;

Group 1	$0 \leq E < 20\%$	low error group
Group 2	$E > 20\%$	high error group

The relationship of these groups to the estimates made by managers of sales forecast uncertainty is made through statistical theory in terms of the normal distribution. A point estimate or forecast of future sales made by managers at the screening stage has a distribution around the estimate which reflects the uncertainty of the estimate. This can be shown as follows, where

S = sales

EV(S) = expected value or point estimate of sales



This distribution can be shown in terms of ranges of sales around the estimate or expected value, which are equivalent to ranges of sales forecast error as shown. In making a sales estimate or forecast at the screening stage, the lower the variance for a manager's distribution around the estimate, the lower the uncertainty attached to the estimate.

The probability of a new product situation falling in a particular range of error shown above is reflected by the area under the curve. For example, the probability of the error being in the range ($0 \leq E < 20\%$) is reflected in the shaded area shown. The greater this area, the lower is the uncertainty attached to the sales forecast for a new product.

C.2.2 Deriving the Descriptive Discriminant Function[2]

This section will outline the mathematics of the derivation of the descriptive linear discriminant function for the case of g groups. The notation for the computational procedure is as follows;

p	=	number of predictor variables
g	=	number of groups
t	=	total number of groups
n_m	=	number of new products situations in group m
m	=	total number of new product situations in all groups
X_{jim}	=	the value of the j^{th} predictor variable for the i^{th} new product situation for group m

As input to the analysis the sets of predictor variables describing the new product situations have been separated into the two groups on the basis of the level of sales forecast error, group 1 (low error) and group 2 (high error). The calculation of the discriminant function then follows this sequence;

a) Means are calculated for each predictor variable X_j

$$\bar{X}_j = \frac{1}{n} \sum_{m=1}^{g} \sum_{i=1}^{n_m} X_{jim} \qquad j = 1,2, \ldots p \qquad \text{(C-3)}$$

b) Group means are calculated for each predictor variable within each group m

$$X_{mj} = \frac{1}{nm} \sum_{i=1}^{n_m} X_{jim} \qquad \begin{matrix} j = 1,2, \ldots p \\ m = 1,2, \ldots t \end{matrix} \qquad \text{(C-4)}$$

c) Group standard deviations are calculated for each predictor variable within

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[2]This section is derived directly from the description of program BMDO7M, Stepwise Discriminant Analysis, in *Biomedical Computer Programs*, W.J. Dixon, Editor, University of California Press, Berkeley, California.

each group in

$$S_{mj} = \sqrt{\frac{1}{n_m - 1} \sum_{i=1}^{n_m} (X_{jim} - \bar{X}_{mj})^2} \qquad \begin{matrix} j = 1,2, \ldots p \\ m = 1,2, \ldots p \end{matrix} \qquad \text{(C-5)}$$

d) Within-group and total group cross-product matrices are calculated

$$W_{ik} = \sum_{m=1}^{g} \sum_{i=1}^{n_m} (X_{jim} - \bar{X}_{mj})(X_{jim} - \bar{X}_{mk}) \qquad \text{(C-6)}$$

$$t_{ik} = \sum_{m=1}^{g} \sum_{i=1}^{n_m} (X_{jim} - \bar{X}_j)\,(X_{jim} - \bar{X}_k) \qquad \text{(C-7)}$$

$$\begin{matrix} j = 1,2, \ldots p \\ k = 1,2, \ldots p \end{matrix}$$

e) Within groups covariance matrix is calculated;

$$V_{ik} = \frac{1}{n-g} W_{ik} \qquad \begin{matrix} j = 1,2, \ldots p \\ k = 1,2, \ldots p \end{matrix} \qquad \text{(C-8)}$$

f) Within groups correlation matrix is calculated;

$$V_{ik} = \frac{W_{ik}}{\sqrt{W_{jj} W_{kk}}} \qquad \begin{matrix} j = 1,2, \ldots p \\ i = 1,2, \ldots p \end{matrix} \qquad \text{(C-9)}$$

g) The coefficients and constant terms of the discriminant functions are calculated

$$b_{ij} = (n-g) \sum_{k=1}^{p} \bar{X}_{ik}\, a_{jk} \qquad \begin{matrix} j = 1,2, \ldots p \\ i = 1,2, \ldots g \end{matrix}$$

$$b_{io} = \frac{1}{2} \sum_{j=1}^{p} C_{ij}\, \bar{X}_{ij} \qquad i = 1,2, \ldots g \qquad \text{(C-10)}$$

The discriminant function is then;

$$Z = b_o + b_1 X_1 + b_2 X_2 + \ldots\ldots b_n X_n \qquad \text{(C-11)}$$

C.2.3 Evaluating the Probability of Sales Forecast Error

Each of the new product situations i has a set of values or multi-dimensional vector of the predictor variables;

$$X_i = (X_{1i}, X_{2i}, \ldots\ldots X_{ni}) \qquad \text{(C-12)}$$

Now, if

$P(I)$ = the unconditional (prior) probability that a new product situation belongs to Group 1 (low error group)

$P(I/X_i)$ = the conditional (posterior) probability that a new product situation belongs to Group 1

$1(X_i/I)$ = the likelihood that a new product situation has the vector of values X_{ij} given that the situation belongs in Group 1.

From Bayes theorem, we have;

$$\frac{P(I/X_i)}{P(II/X_i)} = \frac{1(X_i/I)}{1(X_i/II)} \cdot \frac{P(I)}{P(II)} \qquad \text{(C-13)}$$

or Posterior Odds = Likelihood ratio X Prior Odds (C-14)

The classification procedure will then be as follows. If the odds are strongly enough in favour of Group 1 (low error), classify the new product situation as belonging to Group 1 (if the odds were 3 to 1 in favour of Group 1, this would mean a probability of .75 that the new product situation belongs in Group 1). The logarithm of the odds may also be used as a criterion. For example, odds greater than one (a probability greater than .5) is equivalent to the logarithm of the odds being greater than zero. Equation (C-14) may be written as;

log(posterior odds) = log(likelihood ratio) + log(prior odds) (C-15)

If the two analytical assumptions[3] of normality and equal covariance matrices are true, the logarithm of the likelihood ratio is of the form;

$$\log(\text{likelihood ratio}) = b_o + b_1X_{1i} + b_2X_{2i} + \ldots b_nX_{ni} \qquad \text{(C-16)}$$

It can be seen that this is simply the discriminant function of equation (C-1). In the case of equal prior probabilities of a new product situation being in either group (equal group sizes), the prior odds are then one, and the posterior odds are merely the likelihood ratio. Equation (C-7) then becomes;

$$\log(\text{posterior odds}) = b_o + b_1X_{1i} + b_2X_{2i} + \ldots b_nX_{ni} \qquad \text{(C-17)}$$

Then substituting into equation (C-4);

$$\log \frac{P(I/X_i)}{P(II/X_i)} = (b_o + b_1X_{1i} + b_2X_{2i} + \ldots b_nX_{ni}) \qquad \text{(C-18)}$$

This equation gives the ratio of probabilities of a new product situation belonging to each of the two groups. However, what is really needed is an expression for $P(I/X_i)$ and $P(II/X_i)$. These expressions are derived simply from equation (C-9).

Since

$$P(I/X_i) + P(II/X_i) = 1.0 \qquad \text{(C-19)}$$

Given the value of the discriminant function Z for a particular case, the following calculation can be made;

$$\log \frac{P(I/X_i)}{1-P(I/X_i)} = Z \qquad \text{(C-20)}$$

---

[3]These assumptions and the tests for them are outlined in section 6.6 of Chapter VI.

From this, the value of both $P(I/X_i)$ and $P(II/X_i)$ can be determined.

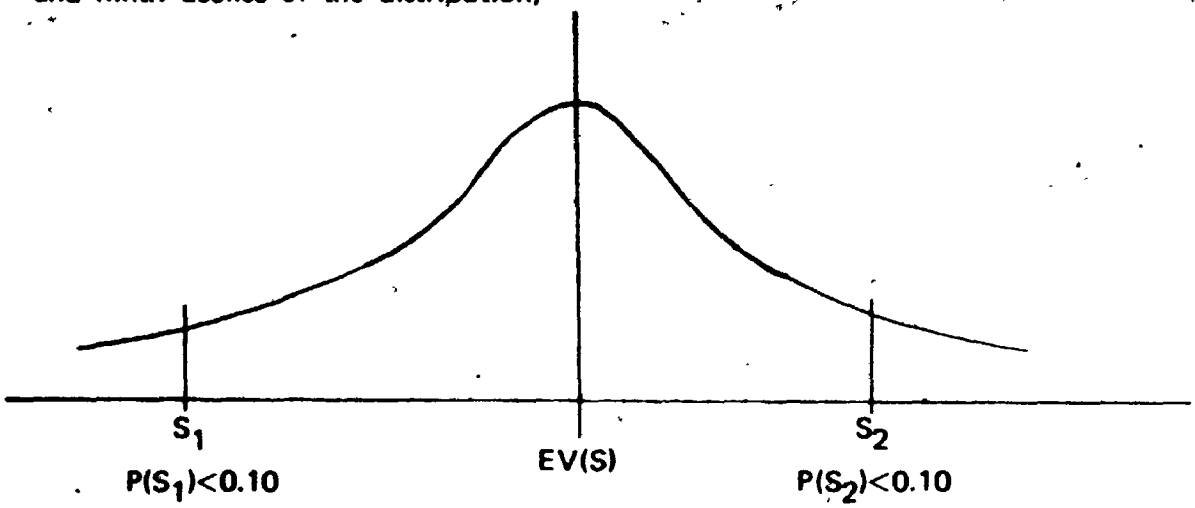
C.2 USE OF THE DISCRIMINANT MODEL IN PREDICTION

Given the descriptive discriminant function developed from a set of new product situations;

$$Z = b_o + b_1X_1 + b_2X_2 + \ldots b_nX_n \qquad \text{(C-21)}$$

Using this function, the probability distribution for sales forecast around an estimate or expected value can be approximated. This distribution can be compared to a distribution generated by managers to evaluate the uncertainty of their sales forecasts.

For example, managers in a aprticular new product screening situation might generate a distribution around an estimate of sales EV(S). A common method used to generate this distribution is presented by Pessemier[4] using managerial estimates of the expected value for sales and the levels of sales represented by the first and ninth deciles of the distribution;



[4]E. A. Pessemier, *New-Product Ventures*, Business Horizons, Vol. 11, 1968.

The managers estimates of the deciles is solicited using a question of the type;

"a sales estimate of S_1 is low enough so there is just one chance in ten that the real outcome would fall below this figure."

The managers response to this question fixes the point S_1. From this, a value for error E can be easily calculated;

$$E = |EV(S) - S_1|$$

and the probability of certain levels of error evaluated. These probabilities of error are direct measures of the managers uncertainty related to forecasts or estimates of sales.

Using the discriminant function and the vector or profile of predictor variables for a new product, the descriptive model can approximate the same distribution for comparison to the managers distribution in screening a particular new product. From the function (ref. section C.2.3),

$$\text{letting } P(o \leq E \leq 20\%) = P1$$

$$\log \frac{P1}{1-P1} = (b_o + b_1 X_{1i} + b_2 X_{2i} + \ldots b_n X_{ni})$$

From this, $P(o \leq E \leq 20\%)$ can be evaluated as well as $P(E > 20\%)$.

These probabilities can be compared directly to the same values from the managers distribution for consistency.

APPENDIX D

SUPPLEMENTARY TABLES OF EMPIRICAL FINDINGS

TABLE D.1

RESULTS OF TWO-WAY DISCRIMINANT ANALYSIS: MARKETING TASK
SIMILARITY VARIABLES (N = 185): ADDITIVE MODEL

Variable Measure	Variable Name	Mean Low Error Group N = 81	Mean High Error Group N = 104	Mean Difference Normalized[a]	Discriminant Function Coefficient	F-ratio on Coefficient
SM_1	Similarity of product characteristics	3.05	2.34	0.61[b]	.00232	6.14[c]
SM_2	Similarity of after-sale service	3.73	3.48	0.23[d]	.00252	2.28[e]
SM_3	Similarity of potential buyers	3.28	2.67	0.58[b]	-.00177	1.07
SM_4	Similarity of distributors	4.68	3.81	0.66[b]	.00122	8.48[b]
SM_5	Similarity of personal selling	3.90	3.56	0.28[c]	.00245	0.58
SM_6	Similarity of advertising	4.09	3.66	0.36[b]	-.00095	0.48
SM_7	Similarity of competitors	3.97	3.74	0.19[d]	.00080	0.15
SM_8	Similarity of product technology	3.65	2.97	0.58[b]	.00035	7.87[b]
	Percent correctly classified, low error group	79%	t = 6.51[b]			
	Percent correctly classified, high error group	63%	t = 2.16[c]			
	Percent correctly classified, overall	70%	t = 4.05[b]			
	F ratio on overall discrimination	5.98[b]				

[a]Mean differences have been normalized by dividing by the standard deviation of each variable.

[b]Significant at > 0.01 level.

[c]Significant at > 0.05 level.

[d]Significant at > 0.10 level.

[e]Significant at > 0.15 level.

[f]Significant at > 0.20 level.

TABLE D.2

RESULTS OF TWO-WAY DISCRIMINANT ANALYSIS:
THE SET OF MOST SIGNIFICANT MARKETING
TASK SIMILARITY VARIABLES (N = 185):
ADDITIVE MODEL

Variable Measure	Name	F-ratio
SM_1	Similarity of product characterisitcs	6.34[b]
SM_2	Similarity of after-sale service	3.31[c]
SM_4	Similarity of distributors	8.83[a]
SM_8	Similarity of product technology	7.83[a]

Percentage correctly classified, low error group.	73%	t = 4.87[a]
Percentage correctly classified, high error group.	65%	t = 2.70[a]
Percentage correctly classified, overall.	70%	t = 4.05[a]
F-ratio on overall discrimination.	9.53[a]	

[a]Significant at ≥ .01 level.

[b]Significant at ≥ .05 level.

[c]Significant at ≥ .10 level.

[d]Significant at ≥ .15 level.

[e]Significant at ≥ .20 level.

TABLE D.3

RESULTS OF THREE-WAY DISCRIMINANT ANALYSIS: MARKETING TASK SIMILARITY VARIABLES (N = 185): ADDITIVE MODEL

Variable Measure	Variable Name	Mean Low Error Group G_1 N=67	Mean Mid-error Group G_2 N=41	Mean High error Group G_3 N=77	Mean Difference $G_1 - G_2$	Mean Difference $G_2 - G_3$	F-ratio on Discriminant Coefficient
SM_1	Similarity of product characteristics	3.06	2.80	2.21	0.22[d]	0.51[a]	4.58[a]
SM_2	Similarity of after-sale service	3.66	3.83	3.40	-0.16[e]	0.39[b]	1.56[d]
SM_3	Similarity of potential buyers	3.28	3.09	2.56	0.18[d]	0.50[a]	0.65
SM_4	Similarity of distributors	4.73	4.29	3.67	0.34[b]	0.47[a]	5.48[a]
SM_5	Similarity of personal selling	3.87	3.85	3.49	0.02	0.31[b]	1.50[d]
SM_6	Similarity of advertising	3.98	4.29	3.48	-0.26[c]	-0.68[a]	3.96[b]
SM_7	Similarity of competitors	3.94	3.85	3.49	0.07	0.29[c]	0.02
SM_8	Similarity of product technology	3.63	3.32	2.93	0.27[c]	0.31[b]	2.63[c]

Percent correctly classified, low error group	58%	t = 0.81[e]
Percent correctly classified, mid error group	49%	t = -1.62
Percent correctly classified, high error group	60%	t = 1.36[e]
Percent correctly classified, overall	57%	t = 0.54
F-ratio on overall discrimination	3.82[a]	

[a]Significant at > .01 level.
[b]Significant at > .05 level.
[c]Significant at > .10 level.
[d]Significant at > .15 level.
[e]Significant at > .20 level.

TABLE D.4

RESULTS OF THREE-WAY DISCRIMINANT ANALYSIS: MARKETING TASK SIMILARITY MEASURES (N = 185) THE SET OF MOST SIGNIFICANT VARIABLES: ADDITIVE MODEL

Variable Measure	Name	F-ratio
SM_1	Similarity of product characteristics	4.66[a]
SM_4	Similarity of distributors	8.66[a]
SM_5	Similarity of personal selling	2.01[c]
SM_6	Similarity of advertising	4.68[a]
SM_8	Similarity of product technology	2.25[b]

Percent correctly classified, low error group.	63%	t = 2.16[a]
Percent correctly classified, mid error group.	51%	t = -1.08
Percent correctly classified, high error group.	59%	t = 1.08[e]
Percent correctly classified, overall.	59%	t = 1.08[e]
F-ratio on overall discrimination.	5.7[a]	

[a]Significant at $\geq$ .01 level.

[b]Significant at $\geq$ .05 level.

[c]Significant at $\geq$ .10 level.

[d]Significant at $\geq$ .15 level.

[e]Significant at $\geq$ .20 level.

TABLE D.5

RESULTS OF TWO-WAY DISCRIMINANT ANALYSIS:
MULTIPLICATIVE MODEL (N = 185)

Name	Group 1 Mean (N=81)	Group 2 Mean (N=104)	Mean Difference (G_1-G_2)	Discriminant Function Coefficient	F-ratio on Coefficient
Index of Marketing Task Similarity I_{SM}	3.63	3.06	0.57[a]	0.0843	14.27[a]
Index of Buyer Risk I_{BR}	2.25	2.44	-0.19	-0.0011	0.50
Index of Competitive Advantage I_{CA}	3.03	3.18	-0.15	-0.0013	0.76
Index of Distribution Ease I_{DE}	1.75	2.04	-0.28	-0.0014	1.90[e]

Percent correctly classified, low error group 72% t = 3.33[a]
Percent correctly classified, high error group 55% t = -1.39[c]
Percent correctly classified, overall 62% t = 0.56
F-ratio on overall discrimination 6.58[a]

[a]Significant at ≥ .01 level.
[b]Significant at ≥ .05 level.
[c]Significant at ≥ .10 level.
[d]Significant at ≥ .15 level.
[e]Significant at ≥ .20 level.

TABLE D.6

RESULTS OF THREE-WAY DISCRIMINANT ANALYSIS:
MULTIPLICATIVE MODEL (N = 185)

Name	Mean Group 1 (N=67)	Mean Group 2 (N=41)	Mean Group 3 (N=77)	Mean Difference (G_1-G_2)	Mean Difference (G_2-G_3)	F-ratio on Coefficient
Index of Marketing Task Similarity I_{SM}	3.60	3.50	2.96	0.10	0.54	9.21[a]
Index of Buyer Risk I_{BR}	2.30	2.23	2.46	0.07	-0.13	0.26
Index of Competitive Advantage I_{CA}	3.03	3.11	3.19	-0.08	-0.08	0.31
Index of Distribution Ease I_{DE}	1.59	2.19	2.04	-0.60	-0.15	5.94[a]

Percent correctly classified, low error group	62%	t = 0.56
Percent correctly classified, mid error group	42%	t = -5.00
Percent correctly classified, high error group	50%	t = -2.78
Percent correctly classified, overall	52%	t = -2.24
F-ratio on overall discrimination	4.96[a]	

[a]Significant at > .01 level.

[b]Significant at > .05 level.

[c]Significant at > .10 level.

[d]Significant at > .15 level.

[e]Significant at > .20 level.

TABLE D.7

RESULTS OF TWO-WAY DISCRIMINANT ANALYSIS: MARKETING TASK COMPLEXITY VARIABLES (N = 185): ADDITIVE MODEL

Variable	Variable Name	Mean Low Error Group N = 81	Mean High Error Group N = 104	Mean Difference Normalized	Discriminant Function Coefficient	F-ratio on Coefficient
	BUYER RISK					
BR_1	Extent of after-sales service	2.45	2.75	-0.27[c]	-.00077	2.67[c]
BR_2	Purchase importance to buyers	2.69	2.77	-0.05	.00074	0.22
BR_3	Technical complexity to buyers	2.53	2.68	-0.09	-.00129	0.00
BR_4	Potential affect on buyer profit	2.60	2.81	-0.27[c]	.00205	0.40
BR_5	Familiarity of purchase task to buyers	2.09	2.33	-0.18[d]	.00004	0.46
BR_6	Relative purchase size to buyers	2.74	2.65	0.13	-.00127	2.63[d]
BR_7	Extent of buyer adaptation	1.84	2.21	-0.33[c]	-.00036	2.83[d]
	COMPETITIVE ADVANTAGE					
CA_1	Extent of patent protection	4.08	3.88	0.12	-.00025	0.09
CA_2	Product uniqueness	2.53	2.96	-0.30[c]	-.00186	1.38[f]
CA_3	Competitive product newness	2.83	3.25	-.027[c]	.00019	0.06
CA_4	Ease of competitive duplication	3.75	3.52	0.27	.00001	0.03
	DISTRIBUTION EASE					
DE_1	Buyer industry diversity	3.25	2.64	-0.24[c]	-.00161	2.82[d]
DE_2	Importance of distributor support	2.04	2.36	-0.13	-.00193	0.46
DE_3	Expected extent of distributor support	1.57	1.75	-0.17	-.00024	0.93
DE_4	Extent of distributor influence on buyers	1.84	2.16	-0.17	.00109	1.18

Percent correctly classified, low error group	63%	t = 0.84[b]
Percent correctly classified, high error group	59%	t = -0.28
Percent correctly classified, overall	60%	t = 0.00
F-ratio on overall discrimination	1.33[e]	

[a]Mean differences have been normalized by dividing by the standard deviation of each variable.

[b]Significant at > .01 level.

[c]Significant at > .05 level.

[d]Significant at > .10 level

[e]Significant at > .15 level.

[f]Significant at > .20 level.

TABLE D.8

RESULTS OF TWO-WAY DISCRIMINANT ANALYSIS: THE SET OF MOST SIGNIFICANT MARKETING TASK COMPLEXITY VARIABLES (N = 185): ADDITIVE MODEL

Variable Measure	Name	F-ratio
BR_1	Extent of after-sale service	3.16[c]
CA_2	Product uniqueness	2.63[c]
DE_1	Buyer industry diversity	3.01[c]
BR_6	Relative purchase size to the buyer	4.04[b]
BR_7	Extent of buyer adaptation	3.45[c]

Percent correctly classified, low error group	66%	t = 2.96[a]
Percent correctly classified, high error group	57%	t = 0.54
Percent correctly classified, overall	62%	t = 1.89[b]
F-ratio on overall discrimination	3.57[b]	

[a]Significant at ≥ .01 level.

[b]Significant at ≥ .05 level.

[c]Significant at ≥ .10 level.

[d]Significant at ≥ .15 level.

[e]Significant at ≥ .20 level.

TABLE D.9

RESULTS OF THREE-WAY DISCRIMINANT ANALYSIS: MARKETING TASK COMPLEXITY VARIABLES (N = 185): ADDITIVE MODEL

Variable Measure	Variable Name	Mean Low error Group G_1 N = 67	Mean Mid error Group G_2 N = 41	Mean High error Group G_3 N = 77	Mean Difference $G_1 - G_2$	Mean Difference $G_2 - G_3$	F-ratio on Discriminant Function Coefficient
	BUYER RISK						
BR_1	Extent of after-sales service	2.52	2.58	2.74	-0.03	-0.17	0.12
BR_2	Purchase importance to buyers	2.64	2.66	2.87	-0.01	-0.07	0.71
BR_3	Technical complexity to buyers	2.68	2.17	2.79	0.43[b]	0.52[a]	4.39[b]
BR_4	Potential affect on buyer profit	2.66	2.56	2.87	0.13[e]	0.41[b]	0.86
BR_5	Familiarity of purchase task to buyers	2.18	2.07	2.35	0.08	0.21[d]	0.86
BR_6	Relative purchase size to buyers	2.73	2.67	2.67	0.10	0.00	0.52
BR_7	Extent of buyer adaptation	1.89	2.05	2.17	-0.15[e]	-0.11	2.07[c]
	COMPETITIVE ADVANTAGE						
CA_1	Extent of patent protection	4.03	4.02	3.88	0.01	0.08	0.12
CA_2	Product uniqueness	2.58	2.73	2.96	-0.10	-0.16[e]	1.64[d]
CA_3	Competitive product newness	2.88	2.88	3.32	0.00	0.36[b]	1.82[d]
CA_4	Ease of competitive duplication	3.72	3.66	3.47	0.08	0.26[c]	0.16
	DISTRIBUTION EASE						
DE_1	Buyer industry diversity	2.18	2.56	2.70	-0.23[d]	-0.08	2.14[c]
DE_2	Importance of distributor support	1.75	2.71	2.38	-0.40[d]	0.14	0.36
DE_3	Expected extent of distributor support	1.48	1.90	1.71	-0.40[b]	0.18[e]	0.17
DE_4	Extent of distributor influence on buyers	1.67	2.46	2.18	-0.48[a]	0.15[e]	0.88
	Percent correctly classified, low error group	64%	t = 1.12[e]				
	Percent correctly classified, mid error group	63%	t = 0.84[e]				
	Percent correctly classified, high error group	47%	t = -3.60				
	Percent correctly classified, overall	57%	t = -0.84				
	F-ratio on overall discrimination	1.49[b]					

[a]Significant at ≥ .01 level.
[b]Significant at ≥ .05 level.
[c]Significant at ≥ .10 level.
[d]Significant at ≥ .15 level.
[e]Significant at ≥ .20 level.

TABLE D.10

RESULTS OF THREE-WAY DISCRIMINANT ANALYSIS: MARKETING TASK COMPLEXITY MEASURES (N = 185) THE SET OF MOST SIGNIFICANT VARIABLES: ADDITIVE MODEL

Variable Measure	Name	F-ratio
CA_2	Product uniqueness	1.90[d]
DE_1	Buyer industry diversity	2.26[c]
CA_3	Competitive product newness	2.05[d]
BR_3	Technical complexity to the buyer	5.58[a]
DE_4	Extent of distributor influence on buyers	6.60[a]

Percent correctly classified, low error group	55%	t = 0.00
Percent correctly classified, mid error group	58%	t = 0.84[e]
Percent correctly classified, high error group	39%	t = -4.30
Percent correctly classified, overall	49%	t = -1.62
F-ratio on overall discrimination	3.46[a]	

[a]Significant at $\geq$ .01 level.

[b]Significant at $\geq$ .05 level.

[c]Significant at $\geq$ .10 level.

[d]Significant at $\geq$ .15 level.

[e]Significant at $\geq$ .20 level.

TABLE D.1T

RESULTS OF TWO-WAY DISCRIMINANT ANALYSIS:
THE SET OF MOST SIGNIFICANT VARIABLES
FOR THE PREDICTIVE MODEL

Variable	Variable Name	F ratio on Coefficient
SM_1	Similarity of product characteristics	4.89[b]
SM_2	Similarity of after-sales service	4.12[b]
SM_4	Similarity of distributors	6.30[b]
SM_8	Similarity of product technology	6.71[a]
BR_1	Extent of after-sales service	1.76[d]
BR_6	Relative purchase size to buyers	1.73[e]
BR_7	Extent of buyer adaptation	2.48[d]
CA_2	Product uniqueness	0.07
DE_1	Buyer industry diversity	1.50[e]

Percent correctly classified, low error group	80%	t = 6.75[a]
Percent correctly classified, high error group	67%	t = 3.24[a]
Percent correctly classified, overall	73%	t = 4.86[a]
F-ratio on overall discrimination	5.02[a]	

[a]Significant at > .01 level.

[b]Significant at > .05 level.

[c]Significant at > .10 level.

[d]Significant at > .15 level.

[e]Significant at > .20 level.

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